MID-CRETACEOUS OSTRACODA FROM SOUTHERN AFRICA AND THE FALKLAND PLATEAU

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(With 42 figures and 14 tables)

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ABSTRACT

Fifty-one species, representing 26 genera are recorded from the Aptian to Cenomanian strata of Zululand, the Agulhas Bank, and the Falkland Plateau (DSDP sites 327 and 330); 35 of the species are new, 10 have previously been described from south-east and east Africa, and Australia, and 6 are left in open nomenclature; 2 new genera (*Makatinella* and *Pongolacythere*), and 1 new subgenus *Hemingwayella (Parahemingwayella)* are erected; 25 new species are formally described: *Cytherella bensoni, Cytherelloidea makatiniensis, C. ndumuensis, Robsoniella falklandensis, Pariceratina liebaui, Cytherura? oertlii, Eucytherura rugosa, E. stellifera, Procytherura batei, Cytheropteron bispinosa, Hemingwayella (Parahemingwayella) barkeri, H. (P.) dalzieli, H. (P.) reticulata, Hemiparacytheridea ewingensis, H. challengeri, Pedicythere falklandensis, Pongolacythere striata, Collisarboris? stanleyensis, Isocythereis? ndumuensis, Makatinella tritumida, M. inflata, Pirileberis makatiniensis, P. mkuzensis, Asciocythere? dubia,* and *Aitkenicythere? striosulcata.*

The marine benthic ostracod faunas of south-east Africa and the Falkland Plateau are compared and contrasted in the context of mid-Cretaceous palaeogeographic refits of south-western Gondwanaland, and Callovian to Aptian (Fauna A) and Albian to Cenomanian (Fauna B) associations are recognized in the South Gondwana ostracod province. Strong Albian faunal links existed between south-east Africa and the Falkland Plateau, which support refits that place the two areas in juxtaposition in Lower Cretaceous times. Environments of deposition are investigated, and water depths of *c.* 200 m and 200–<100 m are postulated for the Falkland Plateau sites and Zululand, respectively.

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INTRODUCTION

Mid-Cretaceous time spans the period in southern African geological history during which its south-eastern margin moved laterally past the Falkland Plateau as the African and South American continental blocks progressively separated in the early opening phase of the South Atlantic Ocean (e.g. Dingle & Scrutton 1974) (see Figs 1, 42 herein.) The commencement of continental drift (as defined by the creation of earliest oceanic crust between the separating continental units) probably dates from about 127 m.y. (Valanginian) (Larson & Ladd 1973), while its continuation resulted in the progressive enlargement of the

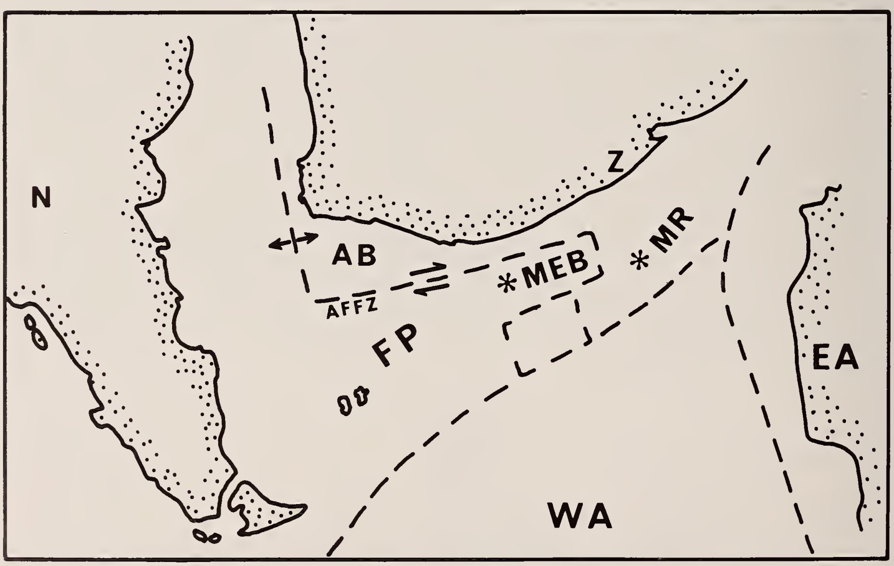

Fig. 1. Sketch of pre-drift reconstruction of part of south-western Gondwanaland. East Antarctica probably began to move away from West Gondwana (South America and Africa) in Jurassic times, but the Falkland Plateau remained in the position shown until latest Valanginian time. Amended from Dingle *et al.* (1983), which was based on Norton & Sclater (1979), Tucholke *et al.* (1981), De Wit (1977), and Elliot (1975). Dashed lines are lines of later continental breakup and arrows show directions of relative motion during continental separation. Stars shows positions of DSDP samples 249 (Mozambique Ridge) and 327 and 330 (Falkland Plateau). Abbreviations: N—Neuquen Basin; AB—Agulhas Bank (Outeniqua Basin); Z—Zululand–South Mozambique Basin; FP—Falkland Plateau; MEB—Maurice Ewing Bank; MR—Mozambique Ridge; WA—West Antarctica microplates; EA—East Antarctica; AFFZ—Agulhas–Falkland Fracture Zone.

south-eastern Atlantic Ocean and the southern Natal Valley. Because of the large spreading ridge offset created by the Agulhas–Falkland Fracture Zone (AFFZ in Fig. 1), the two continents remained physically joined along a progressively shortening zone until about 100 m.y. (late Albian–early Cenomanian). In a consideration of the Barremian to Cenomanian ostracod faunas of south-east Africa it is important, therefore, to include those of the same age from the Falkland Plateau because the Agulhas Bank, Falkland Plateau, and Zululand were close together in a slowly evolving palaeogeography, and their faunas can be expected to show similarities (Fig. 1).

Figure 1 shows a pre-drift reconstruction of the south-east Africa–Falkland Plateau area, and localities from which samples were available for study. Table 1 shows the distribution of the ostracods recovered during the study.

ZULULAND

The mid-Cretaceous (Barremian–Cenomanian) rocks of Zululand crop out as a narrow swathe along the eastern side of the Lebombo Mountains in northern Zululand, at the western edge of the coastal plain (Fig. 2). This is one of the areas from which Kennedy & Klinger (1975) collected during their revision of the Cretaceous ammonite faunas of south-east Africa, and the locality numbers used in Figure 2 are the same as theirs. Kennedy & Klinger (1975) divided the succession into two formations, which are separated by a hiatus across the Aptian–Albian boundary, with Albian I strata missing at outcrop.

The lower, Makatini Formation rests unconformably upon weathered Lebombo lavas, and the oldest marine sediments in this sequence have been dated as late Barremian. Unfortunately, none of the Makatini Formation older than Aptian III contained ostracods and, consequently, all our material comes from the upper two ammonite zones (Aptian III and IV), with exposures in two areas, Mkuze and Mlambongwenya. At the former, localities 152 and 150 occur in the Mantuma rest camp area of the Mkuze Game Park, to the south of the Mkuze River. Locality 150 (27°35,8′S 32°12,47′E) is a cliff section on the southern side of the Nhlohlela Pan, and exposes Aptian III–IV, while locality 152 (27°35,65′S 32°12,88′E) consists of hillslopes south of the road leading to Nhlohlela Pan from Denyer's Drift 500 m west of the camp area (Fig. 3). According to Kennedy & Klinger (1975), the latter exposes a section across the Makatini—Mzinene boundary (Aptian IV, Albian II–III), but only the lower part (Aptian IV) contains ostracods. At the Mlambongwenya Spruit section (locality 171, 27°10,98′S 32°11,13′E) good sections in the river cliff and hillslopes 250 m west-south-west of the store on the main road north from Jozini expose the succession across the Makatini–Mzinene boundary, and in this area ostracods occur in all three ammonite zones involved, Aptian IV, Albian II–III (Fig. 3). Kennedy & Klinger's (1975) work shows that the Albian–Cenomanian boundary is conformable, and that the top of the Mzinene Formation is unconformably overlain by the St. Lucia Formation throughout Zululand, so that the basal rocks of the

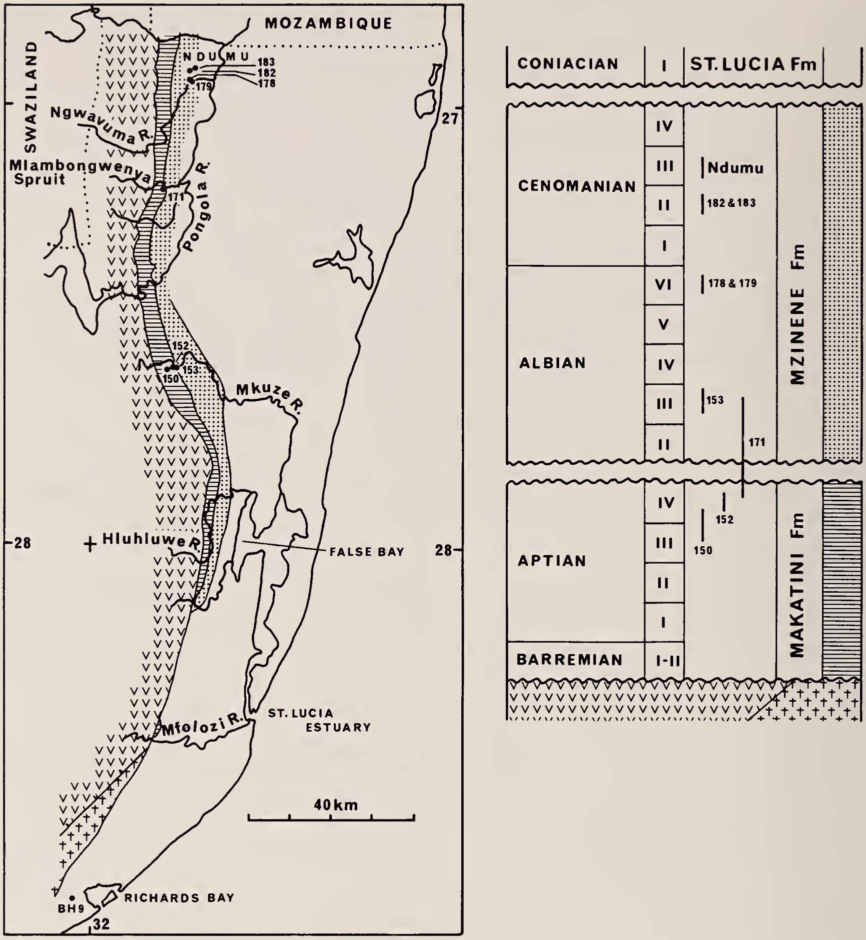

Fig. 2. Mid-Cretaceous strata of Zululand and sampling localities from which ostracods were recovered. Subdivision of stages is after Kennedy & Klinger (1975) and is based on ammonite faunas. Geological map is after Kennedy & Klinger (1975) with minor additions from Dingle *et al.* (1983). Pre-Barremian basement rocks are Mesozoic Lebombo volcanics and Pre-Cambrian metamorphics and granites. Locality numbers are those of Kennedy & Klinger (1975). Barremian I & II ammonite faunas are Upper Barremian in age. BH9 is the Richards Bay borehole, whose ostracod fauna has been described by Dingle (1980).

latter (Coniacian I hereabout) progressively overstep the latter (Cenomanian IV) with the whole of the Turonian missing at outcrop.

As mentioned above, we have ostracods from the basal Mzinene Formation (Albian II at Mlambongwenya Spruit), in addition to material from the next ammonite zone (Albian III) at locality 153 (27°35,60′S 32°13,16′E). This is another Mantuma rest camp exposure, which is in the banks of an excavated site for a reservoir at the camp just east of Dreyer's Drift. Ostracods were not recovered from samples that were taken from ammonite stages Albian IV–V, but material

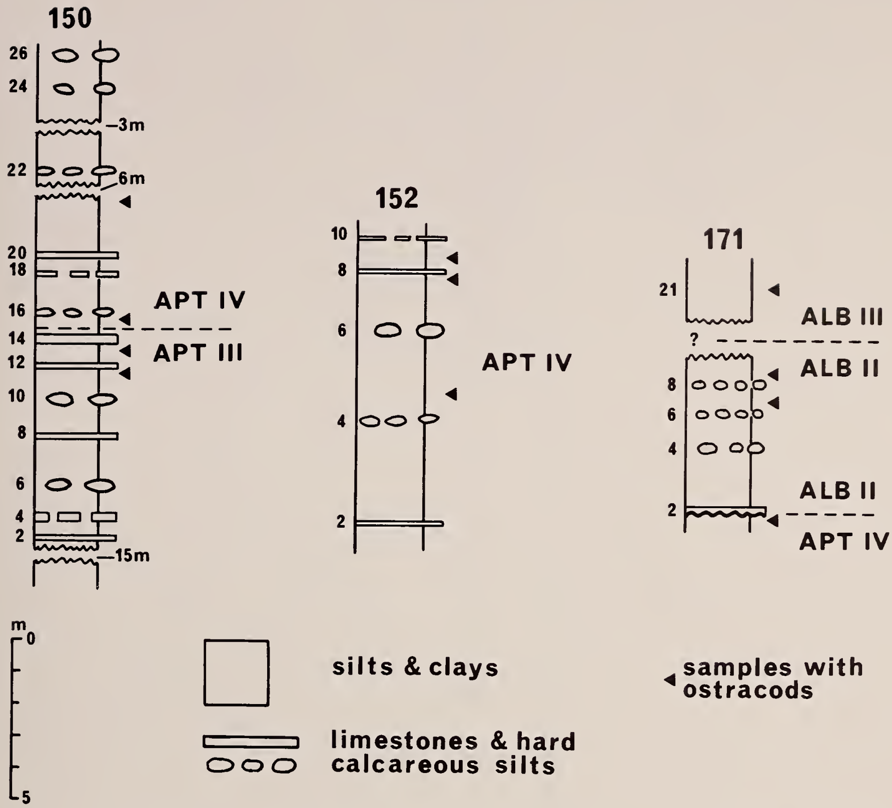

Fig. 3. Measured sections in the Makatini and Mzinene formations of Zululand. See Figure 2 for locations and the text for coordinates. After Kennedy & Klinger (1975), Klinger (pers. comm.), and personal field notes. Locality and bed numbers are those of Kennedy & Klinger (1975). Horizons with ostracod-bearing samples are shown with arrows. Other localities mentioned in the text do not show sections suitable for illustration: 153 is a small quarry exposing a few metres only of calcareous nodules in clays and silts; 178, 179, 182, and Ndumu are scattered outcrops in fields, watercourses and along tracks.

from two localities (178: 26°56,23′S 32°14,42′E, and 179: 26°56,46′S 32°14,92′E) provided fauna of Albian VI age. Both these are in shallow excavations in sisal fields in the vicinity of Msunduzi Pan, south-west of the Ndumu store in northernmost Zululand. Cenomanian I samples did not contain ostracods, but Cenomanian II faunas were recovered from localities 182 (26°55,63′S 32°15,22′E) and 183 (26°55,17′S 32°15,75′E). The former are poor exposures on the hillside south-east of Ndumu store, while the latter were taken in a small quarry in the hillside 300 m below Ndumu police station. The youngest mid-Cretaceous ostracod-bearing sample (Cenomanian III) was collected at the eastern end of Inyamathi Pan in the Ndumu Game Reserve (26°53,0′S 32°18,10′E, referred to as sample 'Ndumu' herein because it was not allocated a locality number by Kennedy & Klinger (1975)). To allow international correlation of the ostracod

TABLE 1
Distribution of mid-Cretaceous ostracods in Zululand, Agulhas Bank and Falkland Plateau

		Aptian			Albian						Cenomanian			
Sp. no.	Zululand ammonite stages / DSDP biostratigraphy	I & II	III	IV	hiatus (early)	II (early)	III (middle)	IV (middle)	V (late)	VI (late)	I (early)	II (early)	III	IV
13	*Majungaella ?hemigymnae*	—	—	*										
43	*Aitkenicythere?* sp. 327/18	—	—	—	—	—	—	*						
10	*Sondagella theloides*	—	—	—	—	—	*	—	*					
12	*Majungaella nematis*	—	—	*	—	—	*	—	—	—	—	*		
46	Indet. sp. 1		*											
6	*Bairdoppilata* sp.1			*										
24	*Procytherura* cf. *aerodynamica*			*										
47	Indet. sp. 2			*										
4	*Cytherelloidea makatiniensis*			*	—	—	*							
20	*Pirileberis mkuzensis*			*	—	—	*							
21	*Makatinella inflata*			*	—	—	*							
23	*Pongolacythere striata*			*	—	—	*							
19	*Pirileberis makatiniensis*			*	—	—	*							
29	*Pariceratina liebaui*				—	—	*	*						
2	*Cytherella* sp.			*	—	*	*	—	—	—	—	*	*	
8	*Paracypris* sp.			*	—	*	*	—	—	*	—	—	*	
22	*Makatinella tritumida*			*	—	*	*	—	—	—	—	*	*	
3	*Cytherelloidea agulhasensis*				*									
18	*Cythereis agulhasensis*				*									
11	*Majungaella* cf. *queenslandensis*				*	—	—	—	*					
32	*Eucytherura stellifera*					*								
44	*Aitkenicythere? striosulcata*					*	*							

15	*Arcuacythere tumida*	*—	*—	*—	*—	*			
30	*Pedicythere falklandensis*		*						
31	*Eucytherura rugosa*		*						
34	*Hemingwayella (Parahemingwayella) dalzieli*		*						
35	*H. (P.) reticulata*		*						
36	*Hemiparacytheridea ewingensis*		*						
37	*H. challengeri*		*						
39	*Asciocythere? dubia*		*						
48	Indet. sp. 330/1		*						
25	*Procytherura batei*		*—	*					
33	*Hemingwayella (P.) barkeri*		*—	*					
40	*Cytheropteron bispinosa*		*—	*					
16	*Isocythereis sealensis*		*—	*—	*—	*			
27	*Sphaeroleberis?* sp.			*—	—	—	*		
26	*Procytherura* cf. *dinglei*			*					
41	*Cytheropteron* sp. 327/18			*					
49	Indet. sp. 327/16A			*					
50	Indet. sp. 327/18			*					
51	Indet. sp. 327/16B			*					
14	*Majungaella?* sp. 327/16			*					
38	*Collisarboris? stanleyensis*			*—	—	*			
45	*Cytherura? oertlii*			*—	—	*			
42	*Cytheropteron* sp.				*				
28	*Monoceratina?* sp.						*		
17	*Isocythereis? ndumuensis*						*—	*—	*
5	*Cytherelloidea ndumuensis*							*	

—*, known extension of range either outside south-east Africa–Falkland Plateau area, or older than mid-Cretaceous

TABLE 1
Distribution of mid-Cretaceous ostracods in Zululand, Agulhas Bank and Falkland Plateau

Sp. no.	Zululand ammonite stages / DSDP biostratigraphy	Aptian I & II	Aptian III	Aptian IV	Albian hiatus (early)	Albian II (early)	Albian III (middle)	Albian IV (middle)	Albian V (late)	Albian VI (late)	Cenomanian I (early)	Cenomanian II (early)	Cenomanian III	Cenomanian IV
13	*Majungaella ?hemigymnae*	—	—	*										
43	*Aitkenicythere?* sp. 327/18	—	—	—	—	—	—	*						
10	*Sondagella theloides*	—	—	—	—	—	*	—	*					
12	*Majungaella nematis*	—	—	*	—	—	*	—	—	—	—	*		
46	Indet. sp. 1		*											
6	*Bairdoppilata* sp.1			*										
24	*Procytherura* cf. *aerodynamica*			*										
47	Indet. sp. 2			*										
4	*Cytherelloidea makatiniensis*			*	—	—	*							
20	*Pirileberis mkuzensis*			*	—	—	*							
21	*Makatinella inflata*			*	—	—	*							
23	*Pongolacythere striata*			*	—	—	*							
19	*Pirileberis makatiniensis*			*	—	—	*							
29	*Pariceratina liebaui*			—	—	—	*	*						
2	*Cytherella* sp.			*	—	*	*	—	—	—	—	*	*	
8	*Paracypris* sp.			*	—	*	*	—	—	*	—	—	*	
22	*Makatinella tritumida*			*	—	*	*	—	—	—	—	*	*	
3	*Cytherelloidea agulhasensis*				*									
18	*Cythereis agulhasensis*				*									
11	*Majungaella* cf. *queenslandensis*				*	—	—	—	*					
32	*Eucytherura stellifera*					*								
44	*Aitkenicythere? striosulcata*					*	*							
7	*Bairdoppilata* sp.2					*	*	*						
1	[illegible]					—	—	*	—	*				
9	*Robsoniella falklandensis*					*	*	*	—	*				
15	*Arculicythere tumida*					*	*	*	*	*				
30	*Pedicythere falklandensis*						*							
31	*Eucytherura rugosa*						*							
34	*Hemingwayella (Paraheming-wayella) dalzieli*						*							
35	*H. (P.) reticulata*						*							
36	*Hemiparacytheridea ewingensis*						*							
37	*H. challengeri*						*							
39	*Asciocythere? dubia*						*							
48	Indet. sp. 330/1						*							
25	*Procytherura batei*						*	*						
33	*Hemingwayella (P.) barkeri*						*	*						
40	*Cytheropteron bispinosa*						*	*						
16	*Isocythereis sealensis*						*	*	*	*				
27	*Sphaeroleberis?* sp.						*	—	—	*				
26	*Procytherura* cf. *dinglei*							*						
41	*Cytheropteron* sp. 327/18							*						
49	Indet. sp. 327/16A							*						
50	Indet. sp. 327/18							*						
51	Indet. sp. 327/16B							*						
14	*Majungaella?* sp. 327/16							*						
38	*Collisarboris? stanleyensis*							*	—	*				
45	*Cytherura? oertlii*							*	—	*				
42	*Cytheropteron* sp.								*					
28	*Monoceratina?* sp.									*				
17	*Isocythereis? ndumuensis*									*	—	*	*	
5	*Cytherelloidea ndumuensis*											*		

—*, known extension of range either outside south-east Africa–Falkland Plateau area, or older than mid-Cretaceous ranges presented herein, Table 2 includes details of the ammonite faunas of Kennedy & Klinger's (1975) zones.

Preservation of the Zululand mid-Cretaceous ostracoda is generally moderate to poor, with signs of local heavy decalcification. Many of the samples collected were barren. This contrasts strongly with the Campanian–Maastrichtian assemblages from Zululand, which are generally well preserved (Dingle 1981), and it suggests local deep weathering (i.e. subaerial exposure) during the Turonian hiatus.

TABLE 2

Ammonite zonation of Barremian to Cenomanian sediments in Zululand (after Kennedy & Klinger 1975).

CENOMANIAN IV: Sparsely fossiliferous. Fauna includes *Calycoceras* gr. *choffati, C. nitidum, C.* gr. *naviculare* and *Eucalycoceras*. Highest parts of the Cenomanian are missing.

CENOMANIAN III: *Turrilites acutus* is abundant throughout, while *Acanthoceras* spp. are abundant in the lower part and *Calycoceras* gr. *choffati* abundant in the upper part. Other forms include *Turrilites costatus, T. scheuchzerianus, Acanthoceras cornigerum, Forbesiceras largilliertianum, F. sculptum, Calycoceras gentoni paucinodatum*, and species of *Desmoceras, Hypophylloceras, Borissiakoceras, Anisoceras, Stomohamites, Sciponoceras, Scaphites, Puzosia*, and *Bhimaites*.

CENOMANIAN II: *Neostlingoceras rorayensis* is common, with the remainder of the fauna consisting of *Hypoturrilites carcitanensis, H. gravesianus, H. tuberculatus, H. nodiferus, Mariella* spp., *Sciponoceras roto, Scaphites*, sp. *Desmoceras latidorsatum, Tetragonites subtimotheanus, Forbesiceras largilliertianum, Sharpeiceras laticlavium, Mantelliceras* spp., and a number of desmoceratids.

CENOMANIAN I: *Sharpeiceras florencae, S. falloti*, and *Mariella oehlerti* are abundant. Other forms include *Desmoceras latidorsatum, Sciponoceras roto, Scaphites* cf. *simplex*, and species of *Mariella, Ostlingoceras, Hypoturrilites*, and *Mantelliceras*.
The local base is drawn at the incoming of abundant representatives of *Sharpeiceras* and *Mariella oehlerti*.

ALBIAN VI: Characterized by the appearance of species of *Durnovarites* and *Stoliczkia*. Species of *Idiohamites, Hamites*, and *Anisoceras* are abundant, while species of *Lechites, Mariella, Hypengonoceras*, and *Tetragonites* and puzosiids are scarcer.

ALBIAN V: Characterized by the abundance of mortoniceratids. Genera present include *Hysteroceras, Oxytropidoceras, Tarfayites, Dipoloceras, Diplasioceras, Mortoniceras, Deiradoceras, Erioliceras, Arestoceras, Cainoceras, Puzosia, Bhimaites, Desmoceras, Hypophylloceras, Anagaudryceras, Gaudryceras, Tetragonites, Hamites, Anisoceras, Labeceras, Myloceras, Jouberticeras*, and *Protetragonites*.

ALBIAN IV: Species of *Oxytropidoceras, Manuaniceras* and *Androiavites* are common. Other genera present include *Pseudhelicoceras, Mojsisovicsia, Hypophylloceras velledae, Jouberticeras*, and *Argonauticeras*, and desmoceratids.

ALBIAN III: *Douvilleiceras* sp., *Anagaudryceras sacya, Eubrancoceras* aff. *aegoceratoides* and *Oxytropidoceras* sp. are abundant; representatives of *Carinophylloceras* are common and *Lyelliceras* frequent. Other forms include *Umsinenoceras, Hypophylloceras, 'Beaudanticeras', 'Cleoniceras', 'Sonneratia', Rossalites, Ammonoceratites, Alopeceras, Argonauticeras* and *Pictetia*.

ALBIAN II: *Douvilleiceras* spp. including *D. orbignyi* and *D. mammillatum*, are abundant. Other forms are scarce, but include *Ammonoceratites, Pictetia* and democeratids and lytoceratids.

ALBIAN I: Absent.
Local base drawn at appearance of representatives of *Douvilleiceras*.

APTIAN IV: Giant, fine-ribbed forms of *Tropaeum* are abundant, and *Lytoceras* is common. Other forms include *Tonohamites, Acanthoplites, Diadochoceras nodosocostatum, Australiceras, Sinzovia, Toxoceratoides, Helicancyloceras*, and *Nonyaniceras*.

APTIAN III: Characterized by an abundance of *Acanthoplites, ?Diadochoceras, Valdedorsella, Phylloceras, Ancyloceras, Protanisoceras, Tonohamites*, and *Lytoceras*. Other forms include *Tropaeum, Australiceras, Toxoceratoides, Helicancyloceras*, and *Nonyaniceras*.

APTIAN II: *Cheloniceras* s.s. becomes frequent, together with *Valdedorsella* or *Pseudohaploceras, Ancyloceras, Tropaeum* and *Australiceras*. Other forms include *Lytoceras, Adouliceras*, and *Toxoceratoides*. A non-sequence may separate Aptian II and I.

APTIAN I: *?Procheloniceras* is abundant. Other forms include *Tropaeum, Ancyloceras, Theganeceras, Lytoceras, Adouliceras*, and *Australiceras*.
Local base drawn at appearance of cheloniceratids.

BARREMIAN II: *Colchidites* spp. occur in very large numbers. Other forms include *Sanmartinoceras, Phylloceras, Lytoceras* and *Ancyloceras*.

BARREMIAN I: Characterized by an abundance of crioceratitids including hemihoplitids and aconeceratids, and species of *'Emericiceras', 'Acrioceras', Heteroceras*, and *?Sanmartinoceras*, and *Phylloceras serum* and *Eulytoceras phestum*. Occasional species of *Colchidites, Lytoceras*, and *Ancyloceras* also occur.
Local base drawn at appearance of ammonite faunas, and the presence of *Colchidites* indicates an Upper Barremian age.

FALKLAND PLATEAU

Leg 36 of the Deep Sea Drilling Project (Barker *et al.* 1977) drilled three holes on the eastern end of the Falkland Plateau. Cores through mid-Cretaceous rocks were collected at sites 327 and 330 from which nine and three ostracod-bearing samples, respectively, were obtained by the writer from the sample repository at the Lamont–Doherty Geological Observatory (Fig. 4). The stratigraphy of these sites has been discussed in detail by Barker *et al.* (1977) (Table 3), and reviewed in the context of their palaeogeographical position adjacent to south-east Africa by Dingle *et al.* (1983).

At both sites, which lie on the western edge of the Maurice Ewing Bank, early–middle Albian nannofossil-rich clays overlie dark, anoxic clays and claystones of Aptian age. The latter do not contain calcareous benthic microfossils, and are considered to have been deposited in stagnant and/or reducing conditions that had persisted over the area since Upper Jurassic times. Sediments younger than Albian were not encountered at site 330, but at 327 the uppermost part of the Cenomanian sequence (core 14) is in a zeolitic clay facies, and this passes, presumably via a non-sequence into Santonian zeolitic claystones. A large hiatus, approximately corresponding to the Upper Cenomanian to Coniacian break in Zululand (Fig. 2) can, therefore, also be inferred on the Falkland Plateau, although by the beginning of this event (Upper Cenomanian), the Falkland Plateau had already separated from the southern tip of the Agulhas Bank (see Fig. 42b).

Ostracods occur at all the sampled levels, with the exception of core 14 (Cenomanian), so that material of early, middle, and late Albian ages was available for study from twelve samples. For simplicity in description, the nine samples from site 327 have been given informal numbers 1–9 (see Table 6). Because the size of each sample was small (*c.* 20 cc), the ostracod faunas were relatively small and vary from 13 to 119 valves. A total of 543 valves was recovered. Many of these are very small specimens, and one of the characteristics of the Falkland Plateau mid-Cretaceous assemblages is the large percentage of micro-ostracods (<450μ length). Preservation varies from good to moderate.

OUTENIQUA BASIN (AGULHAS BANK)

Two samples of mid-Cretaceous age, dredged from the sea-floor south of Plettenberg Bay during geological mapping on the Agulhas Bank, have previously been investigated by Dingle (1971) (see Fig. 42b for locations). In the present study, their small, but relatively well-preserved, ostracod assemblages are re-illustrated with SEM photographs, and the taxonomy revised. These samples turn out to be particularly important because they were deposited adjacent to the Falkland Plateau, and contain a fauna that has elements common to the Falkland Plateau, Zululand, and western Australia.

Sample TBD 1113 (34°15,0′S 23°36,6′E, 95 m water depth). A dark-grey clay containing abundant small unidentifiable shell fragments, glauconite, and comminuted carbonaceous material, and small irregular calcareous nodules. In addition to ostracods, several microfossil taxa have been recorded from this sample, and Luterbacher (reported in Dingle 1971) correlates the benthic foraminiferal assemblage with assemblage zone F (Valanginian to Aptian) of Espitalie & Sigal (1963) from Madagascar (Table 4), and notes that *Epistomina (Brotzenia)* sp. ex gr. *E. (B.) spinulifera* has a range Barremian to Albian. On the basis of calcareous nannofossils, Siesser (1982) suggests a Middle Albian–Maastrichtian age. Overlap of the ranges of these various taxa indicates a Middle–Upper Albian age for sample 1113. Because of the uncertainties of both age and lithostratigraphic correspondence of the Upper Sundays River and lower Alphard formations (e.g. see Dingle *et al.* 1983), assignment of this sample to a lithostratigraphic unit has to be provisional, but it probably belongs to the Alphard Formation. Sample 1113 contained a relatively rich and well-preserved ostracod fauna (5 spp., 91 valves).

Sample TBD 1266 (34°14,1′S 23°23,0′E, 102 m water depth). A stiff dark-grey clay containing abundant unidentifiable shell fragments, and glauconite grains.

Luterbacher (in Dingle 1971) recognized only two benthic foraminifera in this sample, but considered it to be of a similar age to sample 1113 (Table 4). Siesser (1982) dated the sample as Upper Aptian–Lower Santonian on the basis

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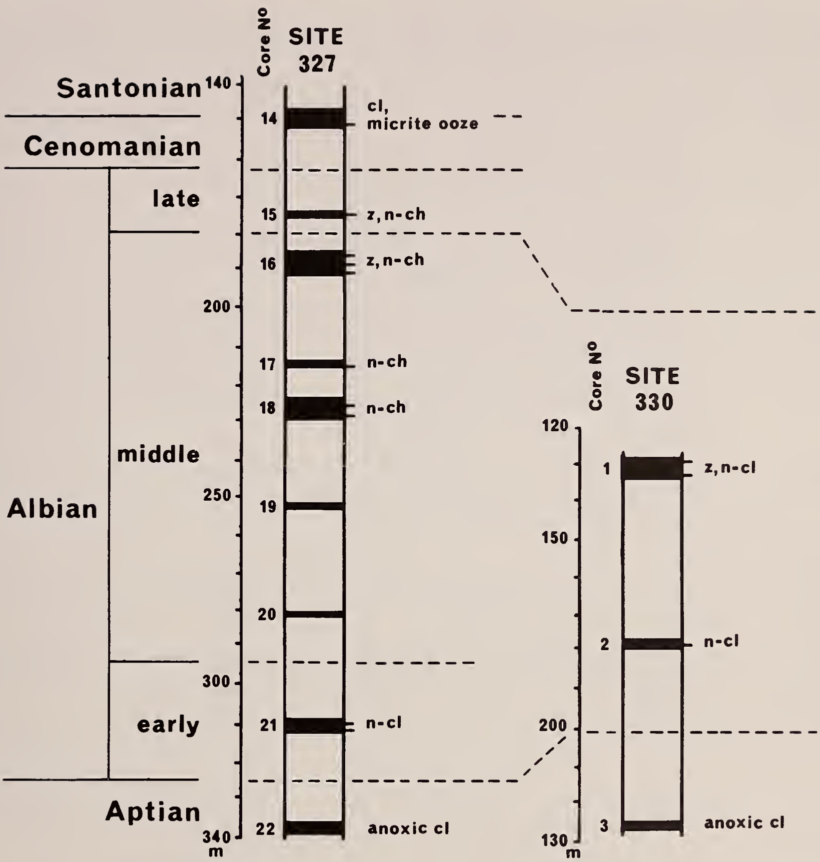
Fig. 4. Stratigraphy and location of DSDP boreholes 327 and 330 on the Falkland Plateau (after Barker *et al.* 1977). Isobaths are in km, depths of the boreholes in m below the sea-floor. Cored sections are black units, and ticks on right side of each column show sediment sample positions, all of which, except core 14, contained ostracods. Lithological notation: cl—clay, z—zeolite-rich, n—nanno, ch—chalk.


SITE 327
Core No
Santonian
Cenomanian
late
middle
Albian
early
Aptian
140
200
250
300
340
m
14
15
16
17
18
19
20
21
22
cl,
micrite ooze
z, n-ch
z, n-ch
n-ch
n-ch
n-cl
anoxic cl
SITE 330
Core No
120
150
200
130
m
1
2
3
z, n-cl
n-cl
anoxic cl

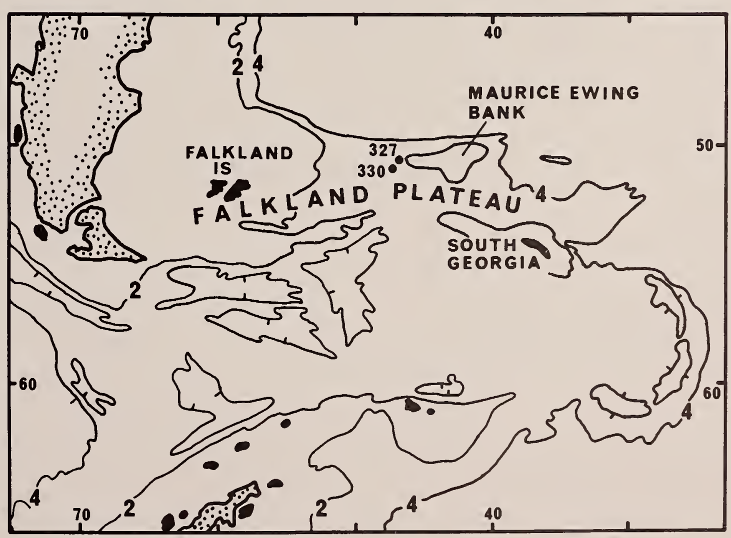

70
40
MAURICE EWING
BANK
FALKLAND
IS
327
330
FALKLAND PLATEAU
SOUTH
GEORGIA
50
60
60
70
40
2
4
2
4
2
2
4
4

TABLE 3

Age determinants in DSDP boreholes 327 and 330 (after Barker *et al.* 1977) (see Fig. 4 for core logs).

SITE 327A	
Core 14	Sections 1–5 contain the coccolith *Marthasterites furcatus* and/or foraminifera which suggest a Santonian age. Section 6 contains *Rotalipora reicheli* and coccoliths which indicate a Cenomanian age.
Core 15	Specimens of *Aucellina*, and coccoliths assigned to *Eiffellithus turriseiffeli* Zone indicate a late Albian age.
Cores 16 to 21	Assigned to *Prediscosphaera cretacea* Zone, which is considered early to middle Albian. Planktonic foraminifera indicate a middle Albian age for cores 16–20 (*Globigerinelloides bentonensis, G. caseyi, Hedbergella delrioensis, H. amabilis, H. portsdownensis*, and *H. planispira*), and early to possibly middle Albian for core 21 (*Hedbergella sigali, H. planispira, H. delrioensis*, and *Globigerinelloides gyroidinaefomis*).
Core 22	Contains the coccolith *Lithostrinus floralis* and is assigned to the *Parhabdolithus angustus* Zone, which is probably late Aptian to early Albian age. Palynomorphs indicate an Aptian age.
SITE 330	
Cores 1 to 2	Contain coccoliths referable to the early–middle Albian *Prediscosphaera cretacea* Zone.
Core 3	Dated Aptian on the basis of coccoliths, foraminifera, and pollen. It probably belongs to the coccolith *Chiastozygus litterarius* Zone.

TABLE 4

Microfossils (other than ostracods) recorded from Agulhas Bank samples 1113 and 1266 (Dingle 1971; Siesser 1982).

FORAMINIFERA	1113	1266
Epistomina (Brotzenia) alveata Espitalie & Sigal	x	x
E. (B.) sp. sp. ex gr. *E. (B.) spinulifera* (Reuss)	x	
E. (B.) sp. aff. *E. (B.) caracolla* (Roemer)	x	x
Lenticulina sp.	x	
Citharinella sp.	x	
Vaginulina (Citharina) sp. aff. *V. (C.) aptiensis* Eichenberg, (cf. sp. 2378C of Espitalie & Sigal 1963)	x	
CALCAREOUS NANOFOSSILS		
Watznaueria barnesae (Black)	x	c
Eiffellithus turriseiffeli (Deflandre)	x	
Lithraphidites carniolensis Deflandre		f
Lithastrinus floralis Stradner		f
Manivitella pemmatoidea (Deflandre)		r
Prediscosphaera spinosa (Bramlette & Martini)		r
Lapideacassis sp.		r
Thoracocphara sp.		r
Zygodiscus sp.		r

x = present, r = rare, c = common, f = frequent of the range of the coccolith *Lithastrinus floralis*. An overlap of the suggested foraminifera and coccolith ranges indicates an Upper Aptian–Albian age, with the sample probably belonging to the Alphard Formation.

Only three ostracod specimens were obtained from sample 1266.

PREVIOUS WORK

Apart from the original descriptions of samples 1113 and 1266 by Dingle (1971), no previous work has been published on mid-Cretaceous (Aptian to Cenomanian) ostracods from southern Africa, although preliminary determinations on the Zululand faunas made from the present work were incorporated in a general survey of Cretaceous ostracod faunas by Dingle (1982). Work on faunas from the originally adjacent areas in Gondwanaland have proved valuable for comparative purposes, and in the discussion section the significance of the close relationships recognized across the whole southern Gondwanaland region will be discussed. Relevant works in this category are: Aptian to Cenomanian from Tanzania (Bate in Bate & Bayliss 1969); Albian from DSDP sites off north-western Australia (Oertli 1974); Albian from the Artesian Basin of Queensland (Krömmelbein 1975); Upper Jurassic–Lower Cretaceous from the Rann of Kutch, India (Guha 1976); Neocomian from the Mozambique Ridge DSDP site 249 (Sigal 1974). In addition, because some of the taxa encountered in the present study range downward into the Upper Jurassic, the studies of Grekoff (1963) on the Middle Jurassic to Valanginian of Madagascar; Dingle (1969); Brenner & Oertli (1976); and McLachlan *et al.* 1976*b* on the ?Portlandian to Hauterivian of the Algoa and Outeniqua basins; and Musacchio (1978, 1979) on the Callovian and Hauterivian of Argentina are also relevant.

A total of 35 fossiliferous samples was available for study, from which 51 species of ostracod were identified (Tables 1, 5). Microfossils were extracted by washing and sieving, and were photographed with a Cambridge S180 Stereoscan at the University of Cape Town, and with a JEOL JSM T200 in the Micropalaeontology Research Unit of University College, London. Specimens were mounted on double-sided Sellotape, and were coated with a gold–palladium mixture. Type specimens and illustrated material were deposited in the South African Museum, Cape Town.

SYSTEMATIC DESCRIPTIONS

The classification used here is based on the Ostracod *Treatise* (Moore 1961), with various additions necessitated by recent work. Abbreviations: RV = right valve, LV = left valve, MPC = marginal pore canal, SCT = subcentral tubercle, TE = terminal element, ATE = anterior terminal element, PTE = posterior terminal element, ME = median element, AM = anterior margin, PM = posterior margin, DM = dorsal margin, VM = ventral margin, NPC = normal pore canal, RPC = radial pore canal, MA = marginal area, and CA = cardinal angle.

Subclass OSTRACODA Latreille, 1806

Order PODOCOPIDA Müller, 1894

Suborder PLATYCOPINA Sars, 1866

Family **Cytherellidae** Sars, 1866

This family is represented by two genera and five species, *Cytherella* (two species) and *Cytherelloidea* (three species), and occurs in all three areas under investigation. Distribution is, however, uneven, with *Cytherelloidea* being confined to the Agulhas Bank and Zululand, and *Cytherella* being relatively more abundant and consistent on the Falkland Plateau. In terms of the CCBC associations (see *Discussion* section), the Cytherellidae are consistently the minor element in the Falkland Plateau assemblages in DSDP 327.

Genus *Cytherella* Jones, 1849

Cytherella is represented by two species, which are restricted to Zululand (*Cytherella* sp.) and the Falkland Plateau (*C. bensoni*). In their respective areas, these are amongst the most abundant and consistently present members of the ostracod populations, although they are never the most important single species.

Cytherella bensoni sp. nov.

Figs 5A–B, 6

Derivation of name

In recognition of the work of Dr R. H. Benson (US National Museum, Washington) on South Atlantic Ostracoda.

Holotype

SAM–PC6017, RV, DSDP 36/327, core 18–6/106–110 cm, middle Albian.

Paratype

SAM–PC6018, LV, DSDP 36/327, core 18–6/106–110 cm, middle Albian.

Diagnosis

Small, fragile species with compressed anterior half, and faint ridges and reticulations in posterior half.

Description

External features. Small, rather fragile shell, subquadrate in lateral outline, with broadly rounded AM with narrow border, narrow truncated PM. DM straight, VM slightly concave. Highest part of valve at about third length. Anterior part of valve compressed, posterior part somewhat swollen, with weakly developed longitudinal ridges and small areas of incipient reticulation that are difficult to see in reflected light. There is a median sulcus with MS impressions.

Interior features. Typical for genus, MS clearly seen as a rosette (Fig. 6).

TABLE 5

Geographical distribution of mid-Cretaceous (Aptian–Cenomanian) Ostracoda from south-east Africa and adjacent areas. (Pre-mid-Cretaceous occurrences are starred.)

Sp. no.		Arg.	F.Plat.	A.B.	Zulul.	M.R.	Mad.	NW Aus.
1	*Cytherella bensoni*		x					
2	*C.* sp.				x			
3	*Cytherelloidea agulhasensis*			x				
4	*C. makatiniensis*				x			
5	*C. ndumuensis*				x			
6	*Bairdoppilata* sp. 1				x			
7	*B.* sp. 2		x					
8	*Paracypris* sp.				x			
9	*Robsoniella falklandensis*		x					x
10	*Sondagella theloides*	x*		x	x	x*		
11	*Majungaella* cf. *queensland-ensis*			x				
12	*M. nematis*	x*		x*	x	x*	x*	
13	*M? hemigymne*				x			
14	*M?* sp. 327/16		x					
15	*Arculicythere tumida*		x	x				x
16	*Isocythereis sealensis*		x	x				
17	*I? ndumuensis*				x			
18	*Cythereis agulhasensis*			x				
19	*Pirileberis makatiniensis*				x			
20	*P. mkuzensis*				x			
21	*Makatinella inflata*				x			
22	*M. tritumida*				x			
23	*Pongolacythere striata*				x			
24	*Procytherura* cf. *aerodyna-mica*				x			
25	*P. batei*		x					
26	*P.* cf. *dinglei*		x					
27	*Sphaerolebris?* sp. A				x			
28	*Monoceratina?* sp.				x			
29	*Pariceratina liebaui*		x					
30	*Pedicythere falklandensis*		x					
31	*Eucytherura rugosa*		x					
32	*E. stellifera*		x					
33	*Hemingwayella (Parahemingwayella) barkeri*		x					
34	*H. (P.) dalzieli*		x					
35	*H. (P.) reticulata*		x					
36	*Hemiparacytheridea ewing-ensis*		x					
37	*H. challengeri*		x					
38	*Collisarboris? stanleyensis*		x					
39	*Asciocythere? dubia*		x					
40	*Cytheropteron bispinosa*		x					
41	*C.* sp.327/18		x					
42	*C?* sp.			x				
43	*Aitkenicythere?* sp. 327/18		x					x
44	*A? striosulcata*		x					
45	*Cytherura? oertlii*		x					x
46	Indet. sp. 1				x			
47	Indet. sp. 2				x			
48	Indet. sp. 330/1		x					
49	Indet. sp. 327/16A		x					
50	Indet. sp. 327/18		x					
51	Indet. 327/16B		x					
	totals 51 spp., 26 genera	2	28	8	19	2	1	4

Arg. = Argentina; F.Plat. = Falkland Plateau; A.B. = Agulhas Bank; Zulul. = Zululand; M.R. = Mozambique Ridge; Mad. = Madagascar; NW Aus. = north-western Australia

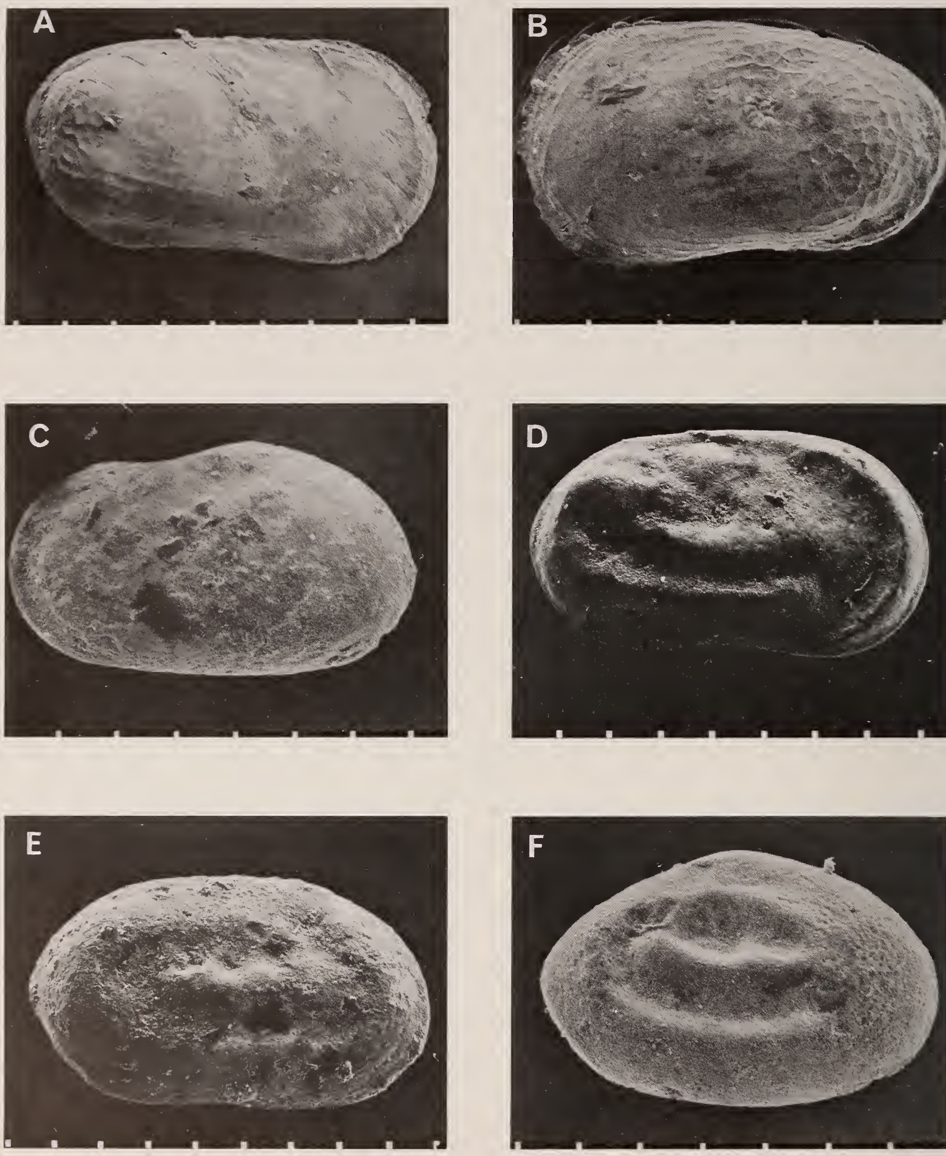


Fig. 5. A–B. *Cytherella bensoni* sp. nov., DSDP 327, core 18–6/106–110 cm, middle Albian. A. Holotype, SAM–PC6017, RV. B. SAM–PC6018, LV. C. *Cytherella* sp. SAM–PC6019, LV, locality 152–5, Mkuze, Zululand, Aptian IV. D. *Cytherelloidea agulhasensis* Dingle, 1971, holotype, SAM–PC6020, RV, TBD 1266, Agulhas Bank, Upper Aptian–Albian. E. *Cytherelloidea makatiniensis* sp. nov., holotype, SAM–PC6021, RV, locality 171–21, Mlambongwenya Spruit, Zululand, Albian III. F. *Cytherelloidea ndumuensis* sp. nov., holotype, SAM–PC6022, RV, locality 182, Ndumu store, Zululand, Cenomanian II.
Scale bars = 100 μ.

Fig. 6. Muscle scars, *Cytherella bensoni* sp. nov., holotype, SAM–PC6017 DSDP 327, core 18–6/106–110 cm, middle Albian. Impressions seen in external view, RV.
Scale bar = 30 μ.

Remarks

The slightly swollen posterior end with incipient ridges may suggest placement within *Cytherelloidea*, but on balance the overall shape and weakness of ornamentation are considered consistent with *Cytherella*.

Dimensions (mm)

	length	height
6017	0,83	0,46
6018	0,60	0,34

Age and distribution

C. bensoni occurs in most of the samples from DSDP sites 327 and 330 on the Falkland Plateau, and ranges over the entire section covered by the core material, i.e. early to middle Albian in 330, and early to late Albian in 327. It is a relatively abundant species (1–15 %, average 7 % in 330, and 5–23 %, average 14 % in 327).

Cytherella sp.

Fig. 5C

Remarks

Poorly preserved specimens of an indeterminate species of *Cytherella*, which has a rounded, inflated posterior area and a compressed anterior area with an incipient AM rim. The specimen illustrated in Figure 5C has a damaged DM, but is otherwise one of the best specimens available.

Age and distribution

Known from the Aptian IV to Cenomanian III interval in Zululand, where it occurs generally in moderate numbers (4–20% total ostracod population).

Genus *Cytherelloidea* Alexander, 1929

This genus is represented by three species that are restricted to the southern African outcrops: *agulhasensis* (Agulhas Bank), and *makatiniensis* and *ndumuensis* (Zululand). Only *C. makatiniensis* occurs in more than one ammonite zone (Aptian IV and Albian III), and none of the species has been recovered in large numbers.

Cytherelloidea agulhasensis Dingle, 1971

Figs 5D, 7C

Cytherelloidea agulhasensis Dingle, 1971: 397–398, fig. 2.

Remarks

No further specimens of this species have been recorded from either Zululand or the Falkland Plateau. SEM photographs show that the rib pattern of *C. agulhasensis* is similar to those of *C. mfoloziensis* Dingle, 1981, and *C. umzambaensis* Dingle, 1969, which range Campanian IV to Maastrichtian II in Zululand, and Santonian to Campanian IV in Transkei–Zululand, respectively.

All three have prominent antero- and posteromarginal, and short longitudinal ventrolateral ribs, but differ in their median and dorsolateral areas, where *C. agulhasensis* has irregular-shaped elevations in contrast to the ribs of the other two species (Fig. 7).

Holotype originally designated MG-5-1-1 (Dingle 1971), now transferred to the South African Museum under designation SAM–PC6020.

Age and distribution

Known only from sample TBD 1266 on the Agulhas Bank (Upper Aptian–Albian, Alphard Formation).

Cytherelloidea makatiniensis sp. nov.

Fig. 5E

Derivation of name

Locality of type specimen, Makatini Flats, northern Zululand.

Holotype

SAM–PC6021, RV, locality 171–21, Mzinene Formation, vicinity of store on Mlambongwenya Spruit, Zululand, Albian III.

Diagnosis

Rib pattern consists of an outer spiral and a short central rib.

Description

External features. AM broadly rounded, DM and VM nearly straight, PM rounded but somewhat truncated ventrally. A broad ridge can be traced from an anterodorsal position round the anterior, ventral, posterior, and dorsal regions in a flattened spiral, ending at about third length. It encloses a short median rib which has two dorsal cusps and a slight anterior swelling. Valve surface otherwise smooth.

Internal features. None seen.

Remarks

The rib pattern of *C. makatiniensis* is reminiscent of *C. mairae* Ramsay from the Campanian of Tanzania (Ramsay 1968), but differs in lacking both a well-defined connection between the middle rib and the outer spiral, and a hook at the posterior end of the middle rib.

Dimensions (mm)

	length	height
6021	0,82	0,49

Age and distribution

C. makatiniensis is known to range Aptian IV to Albian III (Makatini to Mzinene formations) in northern Zululand.

Cytherelloidea ndumuensis sp. nov.

Fig. 5F

Derivation of name

Locality of type specimen, Ndumu Game Reserve, northern Zululand.

Holotype

SAM–PC6022, RV, locality 182, Mzinene Formation, vicinity of Ndumu store, Cenomanian II.

Diagnosis

Species with strongly arched dorsal margin and three short longitudinal ribs.

Description

External features. Asymmetrically elliptical in outline, with evenly curved AM, somewhat acuminate PM, broadly rounded VM and strongly arched DM. The central area of the lateral surface has three short longitudinal ribs, which

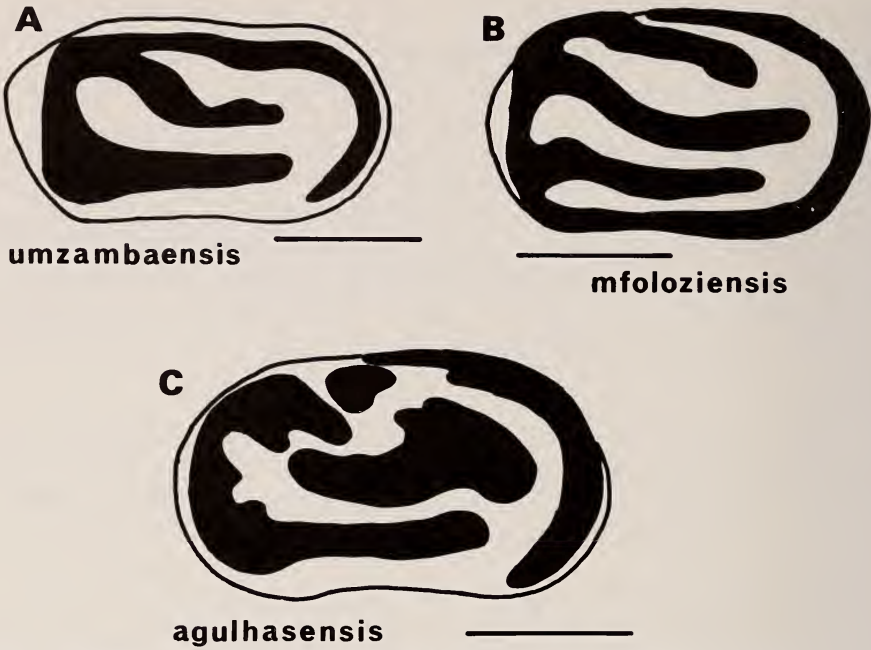


Fig. 7. Sketches of *Cytherelloidea* species, right valves, with positive features shaded. A. *C. umzambaensis* Dingle, 1969, Richards Bay borehole, Zululand, Santonian III (from Dingle 1980, fig. 3a). B. *C. mfoloziensis* Dingle, 1981, SAM–K5665, Mfolozi River, Zululand, Maastrichtian II. C. *C. agulhasensis* Dingle, 1971, SAM–PC6020, Agulhas Bank, Upper Aptian–Albian.
Scale bars = 300 μ.

progressively increase in length ventrally: the dorsal rib is very short and slightly convex dorsally, the middle rib is concave dorsally with a small cusp just in front of the valve mid-length and has a small posterior swelling, and the ventral rib is concave dorsally and curves upward posteriorly to partially enclose the two other ribs. The rest of the valve surface is smooth.

Internal features. None seen.

Remarks

C. ndumuensis has a rather unusual outline and distinctive rib pattern, which sets it aside from other species of the genus in southern Africa.

Dimensions (mm)

	length	height
6022	0,63	0,41

Age and distribution

Known only from the Cenomanian II of northern Zululand.

Suborder Podocopina Sars, 1866

Superfamily bairdiacea Sars, 1888

There is a marked constrast in the importance of this superfamily between Zululand and the Falkland Plateau: in the former it is of minor importance, whereas in the latter it is the dominant element (mainly with *Robsoniella*, consistently occurring at 50% total ostracod population in borehole 327).

Family **Bairdiidae** Sars, 1888

Genus *Bairdoppilata* Coryell, Sample & Jennings, 1935

The genus was recorded from two samples only in the Zululand mid-Cretaceous but, as may be expected, is more abundant in the deeper-water environments of the Falkland Plateau. Despite the poor quality of the comparative material from Zululand, we recognize the species from the two areas as distinct.

Bairdoppilata sp. 1

Fig. 8A

Remarks

Four poorly preserved valves whose closest known comparatives are the late Campanian–early Maastrichtian specimens of *B. andersoni* from the Lower Needs Camp Quarry east of Algoa Bay (Dingle 1981). *Bairdoppilata* sp. 1 differs from the Upper Cretaceous material in having a more broadly rounded AM outline.

Age and distribution

Known only from two Aptian IV horizons in Zululand, locality 152 (Mkuze) and locality 171 (Mlambongwenya Spruit).

Bairdoppilata sp. 2

Fig. 8B

Remarks

Species with an asymmetrically rounded AM and bluntly pointed PM, which distinguishes it from *Bairdoppilata* sp. 1 from Zululand (compare Fig. 8A–B).

Age and distribution

Ranges early to middle Albian at sites 327 (cores 21–3 to 16–6) and 330 (core 1–1) where it occurs in small to moderate numbers (2–22%) of total ostracod population. It is always less abundant than *Robsoniella falklandensis*. Samples with *Bairdoppilata* sp. 2 all cluster in the central portion of the field for site 327 populations on the CCBC diagram (Fig. 38). The significance of this is not known, but may identify median water depth assemblages at this site.

Genus *Robsoniella* Kusnetsova, 1956

In the original description (in Mandelstam *et al.* 1956) and in the *Treatise* (Moore 1961), *Robsoniella* was placed in the family Healdiidae. This seems inconsistent, and the genus is here placed in the family Bairdiidae on the grounds of MA structure and overall shape. *R. falklandensis* occurs on the Falkland Plateau, where it is the dominant taxon both in abundance and distribution, and off western Australia where it is again locally abundant.

Robsoniella falklandensis sp. nov.

Fig. 8C–F

?Indet sp. A, Oertli, 1974; plate 6 (figs 1–11).

Derivation of name

Locality of type specimens on the Falkland Plateau.

Holotype

SAM–PC6025, RV, DSDP 36/327, core 21–4/130–134 cm, early Albian.

Paratypes

SAM–PC6026, RV, DSDP 36/327, core 21–4/130–134 cm, early Albian.
SAM–PC6027, LV, as above.
SAM–PC6028, LV, as above.

Diagnosis

Ovate species with markedly different RV and LV outlines. Hinge weak with a prominent sloping surface over the RV ME.

Description

External features. LV and RV differ considerably in shape, but both are ovate. RV has asymmetric AM with long sloping anterodorsal section, PM more broadly rounded, but also asymmetric. Greatest length below mid-height. DM arched, VM almost straight with median concavity. Greatest height in posterior half. LV is less elongate, AM and PM broadly rounded and almost the same shape, DM arched, VM weakly convex. Both valves smooth overall.

Internal features. MA moderately wide, small vestibule anteriorly, but despite good material, no RPC seen. If present, they must be extremely fine. MS not identified despite good material. Hinge in RV consists of a narrow ME groove and narrow, elongate TE; in LV it consists of a narrow, finely crenulate ME bar and elongate slit-like TE.

Remarks

In outline *R. falklandensis* closely resembles *Bythocypris richardsbayensis* Dingle, 1980, from the Upper Cretaceous of Zululand, but the two differ in hinge structure, MA, MS pattern (very weak in the former, large and prominent

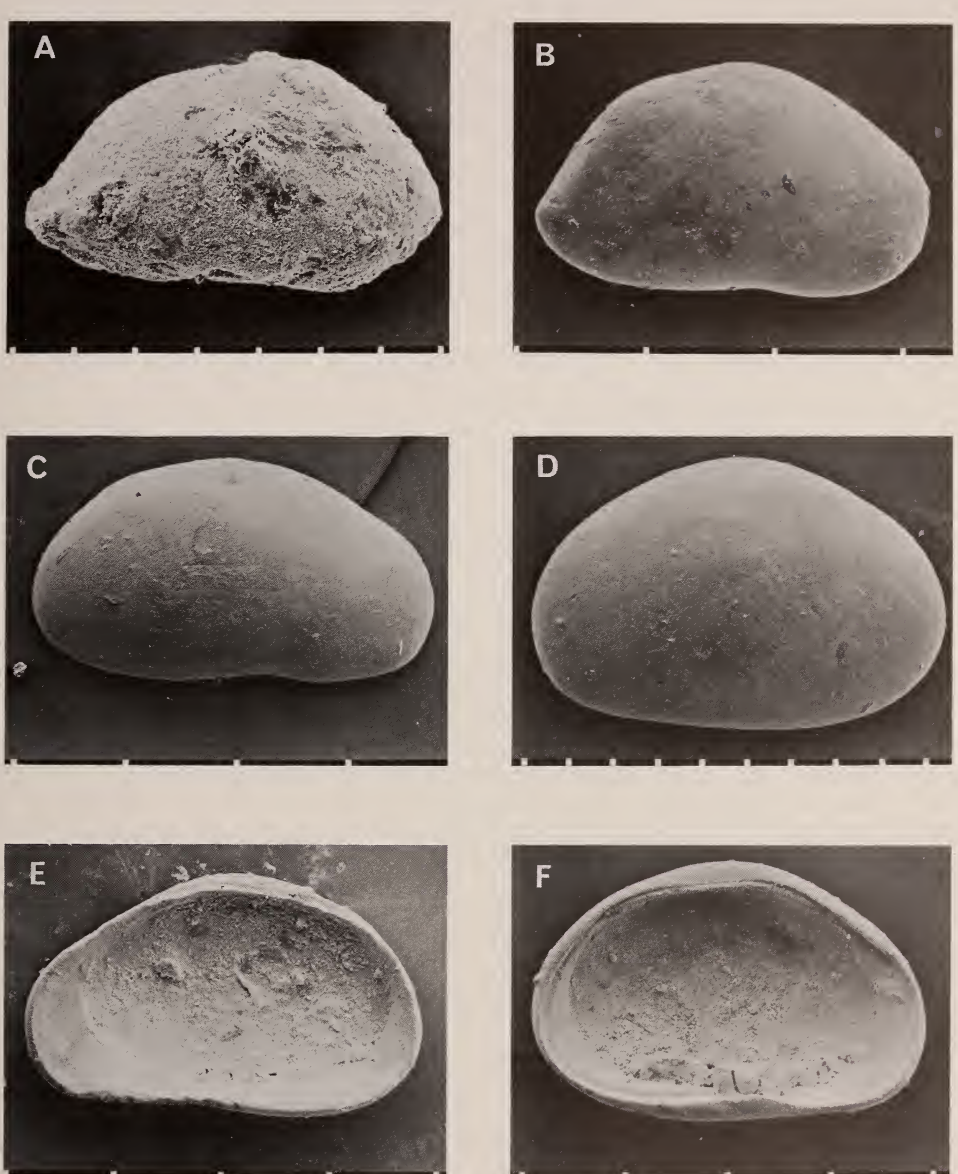


Fig. 8. A. *Bairdoppilata* sp. 1, SAM–PC6023, RV, locality 152, Mkuze, Zululand, Aptian IV. B. *Bairdoppilata* sp. 2, SAM–PC6024, RV, DSDP 330, core 1–1/112–116 cm, early–middle Albian. C–F. *Robsoniella falklandensis* sp. nov., DSDP 327, core 21–4/130–134 cm, early Albian. C. Holotype, SAM–PC6025, RV. D. SAM–PC6026, LV. E. SAM–PC6027, RV, internal view. F. SAM–PC6028, LV, internal view.
Scale bars: A, D = 100 μ, others = 300 μ.

in the latter), with *R. falklandensis* possessing no, or only very fine, RPC. Oertli (1974) records an apparently identical species from off-shore north-western Australia as indet sp. A (*?Robsoniella*), the only difference being the latter's apparently more strongly crenulate hinge elements. *R. falklandensis* differs from the genotype *R. obovata* Kusnetsova from the Aptian–Albian of the Caucasus in lacking well-defined RPC and in having a weaker hinge structure.

Asciocythere sp. 68, recorded by Damotte (1979) from the Aptian of DSDP 400A in north-western Bay of Biscay, has a very similar shape to *R. falklandensis*, but has a longer DM and narrow anterior MA.

Dimensions (mm)

	length	height
6025	1,08	0,60
6026	0,92	0,61
6027	1,08	0,68
6028	1,14	0,75

Age and distribution

R. falklandensis is by far the most abundant ostracod taxon in the early to late Albian of DSDP boreholes 327 and 330, where it occurs in every sample investigated except that from core 14–6/126–130 cm (Cenomanian), which did not contain ostracods. The species varies from 19 to 54% (average 35%) of total fauna at site 330, and from 15 to 70% (average 48%) at site 327.

Oertli (1974) recorded the species in four samples at DSDP site 260 (cores 9–11, Middle–Upper Albian) off north-western Australia, where it was also the dominant taxon.

Superfamily CYPRIDACEA Baird, 1845

Family **Paracyprididae** Sars, 1923

Genus *Paracypris* Sars, 1866

There was a marked disparity in the distribution of this genus in mid-Cretaceous times in the south-east Africa–Falkland Plateau area: it is sparse to abundant in Zululand, but has not been recorded from the Agulhas Bank or the Falkland Plateau. It may also be significant to note here that *Paracypris* is absent from the Portlandian to Hauterivian of the Algoa–Outeniqua basins (Dingle 1969; Brenner & Oertli 1976; McLachlan *et al.* 1976*b*), and only two valves were recorded from the Maastrichtian III of the Agulhas Bank, while the genus is relatively diverse and abundant in the Upper Cretaceous of Zululand (including the JC–1 borehole) (Dingle 1981). This strongly suggests latitudinal (thermal) control of the distribution of *Paracypris* in south-east Africa during Cretaceous times.

Paracypris sp.

Fig. 9A

Remarks

Although relatively abundant, specimens are poorly preserved, with good internal views not available. *Paracypris* sp. has a distinctive drawn-out PM and in this respect is very similar to *P. umzambaensis* Dingle. It may be a separate taxon because of its less symmetric DM outline, but MS patterns need to be seen to resolve the question.

Age and distribution

Paracypris sp. is known to range Aptian IV to Cenomanian III in Zululand, while its closest local relative (*P. umzambaensis*) is known from the Santonian to Maastrichtian in Zululand (Dingle 1981).

Superfamily CYTHERACEA Baird, 1850

There is a marked contrast in the importance of this superfamily between south-east Africa and the Falkland Plateau. In Zululand, cytheraceans (expressed as numbers of valves within the total ostracod population) dominate over the Cytherellidae and Bairdiacea–Cypridacea, whereas on the Falkland Plateau they are consistently subordinate to the Bairdiacea–Cypridacea elements. On the other hand, on the Falkland Plateau 89% of the species present are cytheraceans, whereas in Zululand they make up only 75% of the extant species. In other words, the Falkland Plateau cytheracean fauna is more diverse but numerically sparser than its Zululand counterpart. A further contrast is found on the Agulhas Bank, where cytheraceans constitute 100% of the ostracod population in Sample 1113, yet only two species account for 99%: an abundant but very restricted cytheracean element.

Family **Bythocytheridae** Sars, 1926

Genus *Monoceratina* Roth, 1928

Monoceratina? sp.

Fig. 9B

Remarks

One poorly preserved specimen showing the typical median sulcus and ventromedian projection of the genus. Hinge not observed, so generic placement is uncertain.

Age and distribution

Albian VI, Mzinene Formation at locality 178, Ndumu, Zululand.

Genus *Pariceratina* Gründel & Kozur, 1971

Pariceratina liebaui sp. nov.

Fig. 9C–D

?Nemoceratina (Pariceratina) sp. Liebau, 1977: 110–111, pl. 1C–F.

Derivation of name

After Dr A. Liebau, University of Tübingen, who first illustrated specimens probably belonging to this species.

Holotype

SAM–PC6031, LV, DSDP 36/330, core 1/cc, early–middle Albian.

Paratype

SAM–PC6032, LV, as for holotype.

Diagnosis

Species with lance-like posteroventral spine, prominent spine in anterodorsal area, and fan-like microconation on posterodorsal area.

Description

External features. Elongate quadrate. Rounded AM bearing numerous fine elongate spines, PM asymmetrically acuminate with apex above mid-height, posteroventral area spinose. DM straight, VM slightly concave about mid-length. Ventrolateral areas bear three conical elevations on a wide ridge: posterior elevation has a lance-like spine with numerous small spines around its base; median elevation is low with a small cluster of two to three spines; anterior elevation is larger with numerous small, stud-like spines. There is a prominent spine in the anterodorsal area which projects beyond the DM in lateral view. Surface ornamented with what Liebau (1977) terms microconate protoreticulation (string-of-beads-like muri), and occasional larger spines. The posterior part of the valve has a particularly delicate ornamentation with a fan-like arrangement of microconate strings on the posterior apex.

Internal features. MA moderately wide. Hinge simple and straight, with a smooth bar, slightly expanded anteriorly in LV and complementary groove in RV. MS not seen.

Remarks

P. liebaui is similar to *P. trispinosa* (Neale 1975) from the Santonian of western Australia, but the latter is less elongate and has a more rounded AM outline. The genus has been reported from the Maastrichtian of Zululand (*P. hirsuta*) by Dingle (1981), but this species has an overall spinose ornamentation and a somewhat different PM outline. Liebau (1977) illustrated two specimens from the Upper Aptian near Hanover, West Germany, that appear to be identical to our material.

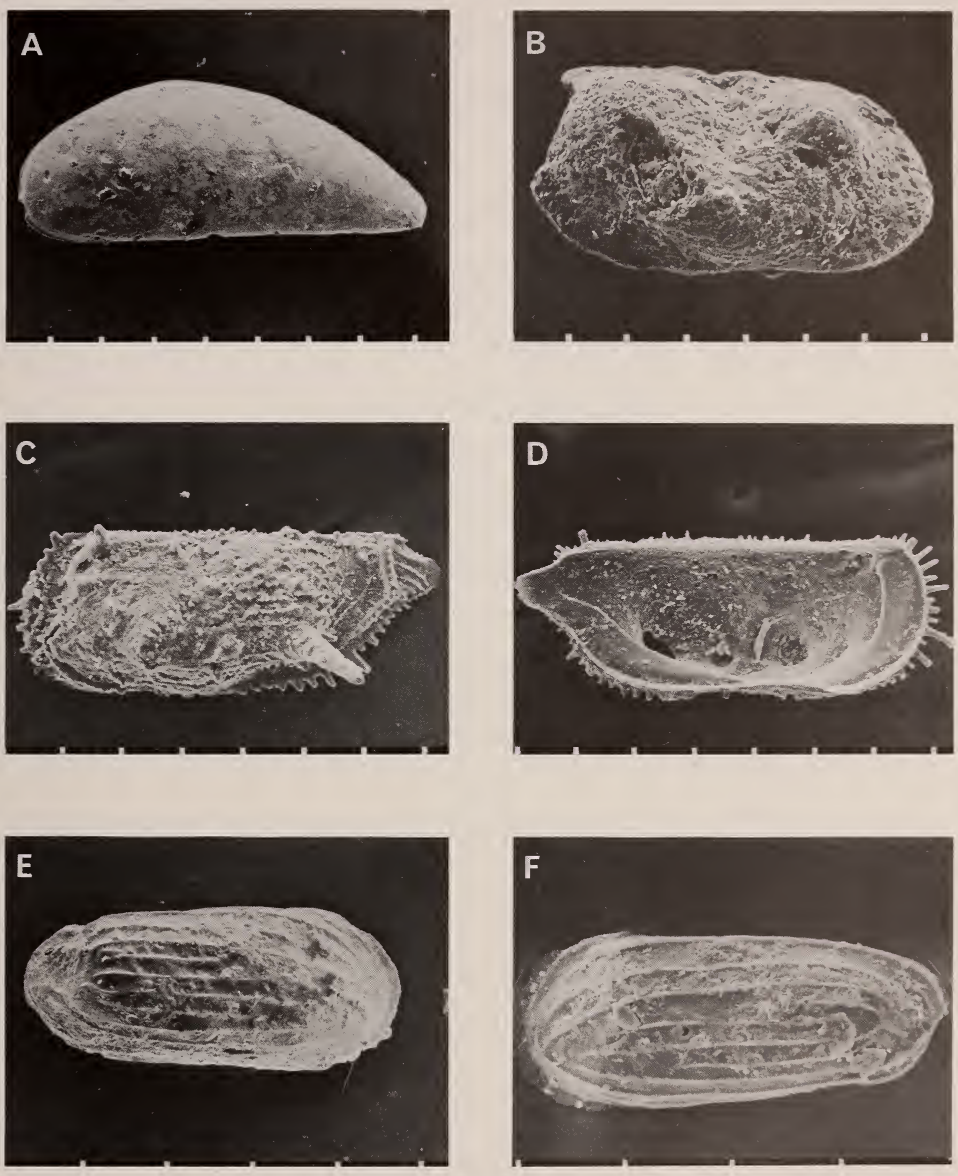


Fig. 9. A. *Paracypris* sp., SAM–PC6029, LV, locality 171–7, Mlambongwenya Spruit, Zululand, Albian II. B. *Monoceratina?* sp., SAM–PC6030, RV, locality 178, Msunduzi, Zululand, Albian VI. C–D. *Pariceratina liebaui* sp. nov., DSDP 330, core 1/cc, early–middle Albian. C. Holotype, SAM–PC6031, LV. D. SAM–PC6032, LV interior view. E–F. *Cytherura? oertlii* sp. nov., DSDP 327. E. Holotype, SAM–PC6033, RV, core 18–6/106–110 cm, middle Albian. F. SAM–PC6034, LV, core 15–2/132–136 cm, late Albian.
Scale bars = 100 μ.

Dimensions (mm)

	length (incl. spines)	height
6031	0,72	0,28
6032	0,72	0,26
Liebau's specimen	0,79	0,28

Age and distribution

P. liebaui ranges early–middle Albian at DSDP site 330 (core 1–cc to 1–1/112–116 cm), and middle Albian at site 327 (core 16–1/55–59 cm), where it occurs in small numbers (1–3 % total ostracod population at both sites).

Family **Cytheruridae** Müller, 1894

Subfamily Cytherurinae Müller, 1894

In Zululand, the subfamily Cytherurinae is represented by one species (*Procytherura* cf. *aerodynamica*) at one locality, where it accounts for only 2 % of the total ostracod population. On the Falkland Plateau, on the other hand, the subfamily represents one of the most important elements of the ostracod population, 7 genera in 13 species, and these abundant micro-ostracods constitute one of the characteristic features of the Falkland Plateau Albian assemblages. Considered in terms of the total ostracod population, the Cytherurinae form 18 % (mean of 3 samples) at site 330, and 5 % (mean of 9 samples) at site 327, but as a percentage of the cytheraceans, they are 34 % (max. 44 %) at site 330, and 17 % (max. 33 %) at site 327.

Genus *Cytherura* Sars, 1866

Cytherura? oertlii sp. nov.

Figs 9E–F, 10

Indet sp. B. Oertli, 1974: 949, pl. 7 fig. 1.

Derivation of name

After Dr H. J. Oertli (Société Nationale Elf Aquitaine) who first recorded the species.

Holotype

SAM–PC6033, C, DSDP 36/327, core 18–6/106–110 cm, middle Albian.

Paratype

SAM–PC6034, C, DSDP 36/327, core 15–2/132–136 cm, late Albian.

Diagnosis

Elongate species, DM and VM parallel, ornamented with fine longitudinal ribs.

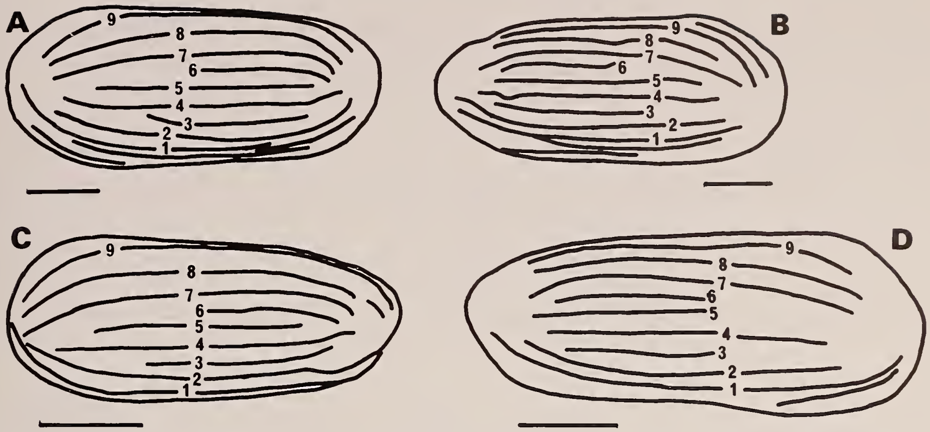


Fig. 10. Comparison of rib patterns in specimens of *Cytherura? oertlii* sp. nov. Numbering system has no significance other than to compare equivalent ribs. A. SAM–PC6034, LV, DSDP 327, core 15–2/132–136 cm, late Albian. B–C. Holotype, SAM–PC6033 RV(B), LV(C), DSDP 327, core 18–6/106–110 cm, middle Albian. D. Specimen illustrated by Oertli (1974, plate 7 (fig. 1)) as indet. sp. B from DSDP 260, core 9/cc, north-western Australia, Middle–Upper Albian. Scale bars = 100 μ.

Description

External features. Small, elongate, DM and VM parallel, asymmetrically rounded AM, narrower, slightly acuminate PM with incipient caudal process. Valve surface ornamented with nine fine longitudinal ribs, the most prominent being numbers 1, 2, 4, 7, 8, and 9 (see Fig. 10). In LV, rib 1 curves partly round the AM area, and in both valves the lower two ribs converge posteriorly with the upper three.

Internal features. None available.

Remarks

Tentatively placed in *Cytherura* on valve shape and ornamentation. Oertli's (1974) specimen from off-shore western Australia has an identical rib pattern to *C? oertlii* (Fig. 10).

Dimensions (mm)

	length	height
6033	0,53	0,23
6034	0,40	0,16
Indet. sp. B. Oertli, 1974	0,47	0,18

Age and distribution

C? oertlii ranges middle to late Albian in DSDP 327 (cores 18–6/106–110 cm to 15–2/132–136 cm), where it is rare (3–5%), and Middle–Upper Albian in DSDP 260 (core 9/cc) off north-western Australia.

Genus *Eucytherura* Müller, 1894

Eucytherura rugosa sp. nov.

Fig. 11A–C

Derivation of name

Latin *rugosa* (rough): reference to rough, corrugated surface ornamentation.

Holotype

SAM–PC6035, LV, DSDP 36/330, core 1/cc, early–middle Albian.

Diagnosis

Species with wedge-shaped eye tubercle, coarsely reticulate surface ornamentation, and posteriorly deflected ala termination.

Description

External features. Subquadrate outline. Broadly rounded AM with a few short, stout, sharp spines anteroventrally, straight DM, pointed PM with apex in line with DM. VM almost straight, converging slightly with DM. There is a large wedge-shaped eye tubercle below the anterior CA, and a smaller wedge-shaped elevation at the posterior CA. A sharp, rugose ventrolateral ridge lies on the upper edge of a prominent ala terminating posteriorly in a rough, blade-like spine. A similar second spine lies along the trailing edge of the ala, whose ventral surface has several low ridges. The valve surface overall is covered by coarse reticulation bearing small mural spines. Over the posterior part of the ala this reticulation takes the form of transverse corrugation.

Internal features. MA wide (RPC not seen). MS not seen. Hinge in LV consists of a crenulate median bar and small, rounded TE.

Remarks

E. rugosa closely resembles *E. stellifera* sp. nov. from DSDP 327, but differs on the following points: different reticulate ornamentation pattern; the eye tubercle of *E. stellifera* projects forward; and the ventrolateral ridge of *E. stellifera* is more sharply defined and lies in a more median position in its anterior part. In addition, the ATE RV hinge of *E. rugosa* consists of a rounded pit, compared to a more elongate socket that lies partly above the anterior end of the ME in *E. stellifera*. Bate (in Bate & Bayliss 1969) recorded *E. tanzanensis* from the Upper Aptian of Tanzania but, although it also possesses a coarse reticulate ornamentation, it differs from *E. rugosa* in shape, particularly the PM.

Dimensions (mm)

	length	height
6035	0,24	0,14

Age and distribution

E. rugosa is known only from the early–middle Albian of DSDP 330 (core 1/cc) on the Falkland Plateau.

Eucytherura stellifera sp. nov.

Fig. 11D–F

Derivation of name

Latin *stellifera* (starry, star-bearing): reference to star-like pattern of mural spines.

Holotype

SAM–PC6036, LV. DSDP 327, core 21–3/71–76 cm, early Albian.

Diagnosis

Species with reticulate ornamentation that has a stellate orientation of mural spines.

Description

External features. Subquadrate in lateral view, slightly asymmetrically rounded AM, straight DM, acuminate PM with apex along line of DM, VM almost straight. Eye tubercle is large and angular, has a somewhat twisted appearance, and projects slightly forward. There is a low elongate swelling over the posterior CA. Ventrolaterally the valve is inflated and alate, with a short terminal spine projecting posteriorly. The ala has a ribbed leading edge that extends forward into the anterior quarter of the valve. A second blade-like spine occurs on the ala trailing edge. Entire lateral valve surface ornamented with a coarse reticulation that is particularly well developed in the median areas. Muri bear short, sharp spines that project inward, producing a stellate arrangement.

Internal features. No MA or MS seen. Hinge in LV consists of a long straight crenulate bar, a small elongate indistinct PTE, and a small ATE that extends over the dorsal end of the ME.

Remarks

E. stellifera is very close to *E. rugosa* and differs primarily on ornamentation, although other differences have been listed under the *Remarks* section for the latter species. The ornamentation of *E. tanzanensis* Bate from the Upper Aptian of Tanzania is similar to that of *E. stellifera*: 'small denticular processes grow into the 5–6 sided pits', but this species has only a small eye tubercle, and differs considerably in outline, especially the PM. Similarly, *E. antipodum* Neale, 1975, from the Santonian of western Australia has a well-developed reticulate ornamentation, but differs from *E. stellifera* in details of ala shape, PM outline, and size of eye tubercle.

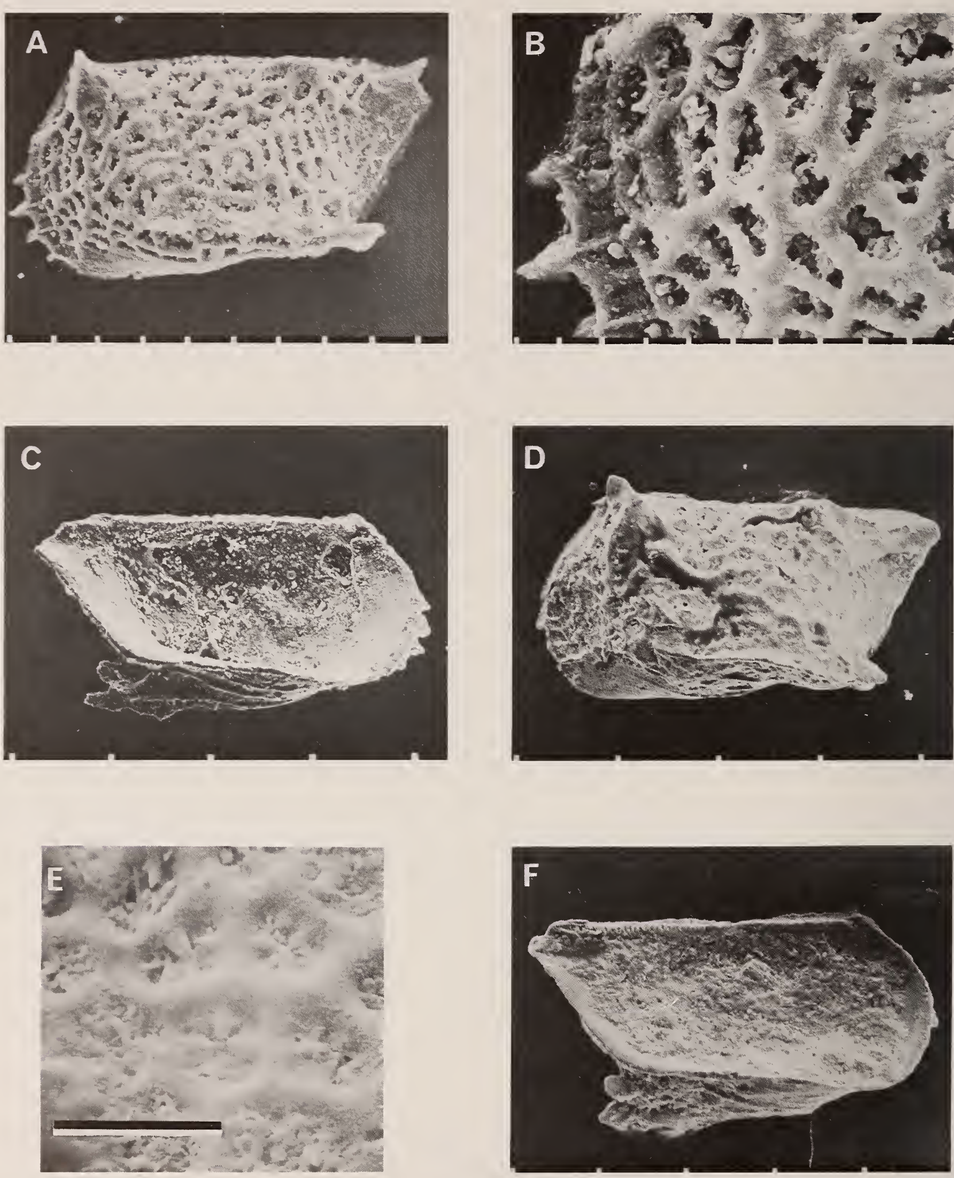


Fig. 11. A–C. *Eucytherura rugosa* sp. nov., holotype, SAM–PC6035, LV, DSDP 330, core 1/cc, early–middle Albian. A. External view. B. Detail of anterior area. C. Internal view. D–F. *Eucytherura stellifera* sp. nov., holotype, SAM–PC6036, LV, DSDP 327, core 21–3/71–76 cm, early Albian. D. External view. E. Detail of ornamentation, central part of valve. F. Internal view.
Scale bars: A, E = 30 μ, C–D, F = 100 μ.

Dimensions (mm)

	length	height
6036	0,34	0,21

Age and distribution

E. stellifera is known only from the early Albian of DSDP 327 (core 21–3/71–76 cm) on the Falkland Plateau.

Genus *Procytherura* Whatley, 1970, emend. Bate & Coleman, 1975

Procytherura cf. *P. aerodynamica* Bate, 1975

Fig. 12A

Remarks

A single broken valve that has a similar outline to that of *P. aerodynamica* Bate from the Lower–Upper Kimmeridgian of Tanzania. The specimen is closest to that illustrated in plate 11 (fig. 11) of Bate (1975) (which was regarded as a juvenile), but differs in being more acuminate posteriorly than the east African form.

Brenner & Oertli (1976) described three species of *Procytherura (maculata, beerae, dinglei)* from the Lower Sundays River Formation (Upper Valanginian to Lower Hauterivian) of the Algoa Basin (south-east Africa), but all three have distinct ornamentation, whereas the specimen from Zululand is smooth.

Age and distribution

Aptian IV, Makatini Formation, locality 171 at Mlambongwenya Spruit, northern Zululand.

Procytherura batei sp. nov.

Fig. 12B–C, E

Derivation of name

After Dr R. H. Bate (previously of the British Museum (Nat. Hist.)) for his contribution to knowledge of east African Mesozoic Ostracoda.

Holotype

SAM–PC6038, LV, DSDP 36/327, core 16–4/66–70 cm, middle Albian.

Paratypes

SAM–PC6039, LV, as above.
SAM–PC6040, C, as above.

Diagnosis

Ovate species with pointed PM, punctate, weakly reticulate ornamentation, and bevelled AM and PM borders.

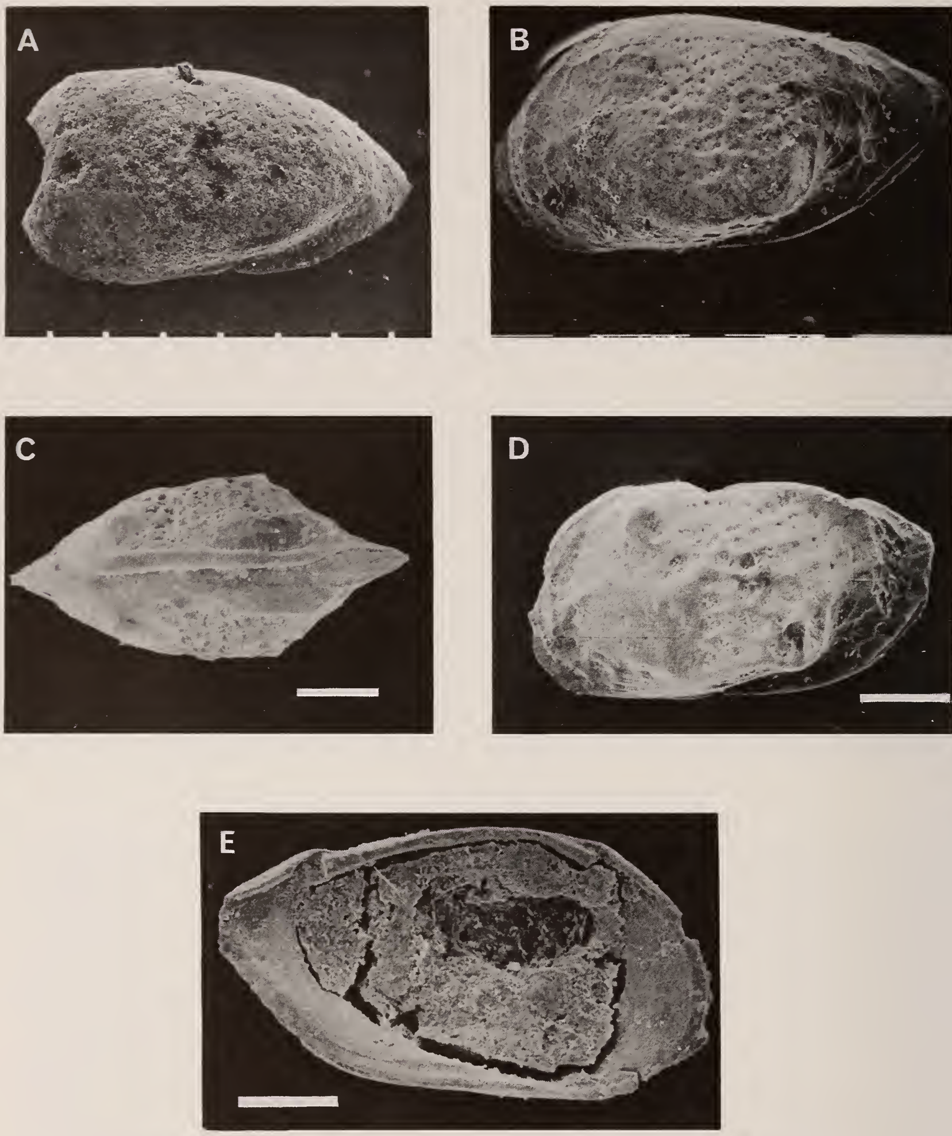


Fig. 12. A. *Procytherura* cf. *P. aerodynamica* Bate, 1975, SAM–PC6037, LV, locality 171–1, Mlambongwenya Spruit, Zululand, Aptian IV. B–C, E. *Procytherura batei*, sp. nov., DSDP 327, core 16–4/66–70 cm, middle Albian. B. Holotype, SAM–PC6038, LV. C. SAM–PC6040, C, dorsal view, anterior to the left. E. SAM–PC6039, LV, internal view. D. *Procytherura* cf. *P. dinglei* Brenner & Oertli, 1976, SAM–PC6041, DSDP 327, core 16–6/126–130 cm, middle Albian.
Scale bars = 100 μ.

Description

External features. Ovate, with rounded AM, PM asymmetrically acuminate with rounded apex above mid-height. DM weakly convex, VM straight, DM and VM converge slightly posteriorly. AM and PM have a narrow bevelled border. Greatest height in anterior third. There is a prominent ventrolateral swelling, giving the valve an almost alate appearance. A small angular eye swelling occurs just below the anterior CA of each valve. Surface punctate with indistinct reticulation that is best developed in posterior areas. In dorsal view carapace is almost diamond-shaped, with a prominent RV on to LV overlap along DM. DM in RV has a thicker rim.

Internal features. Hinge holoperatodont, with thickening of LV ME that turns down at its anterior end. MS not seen. MA wide, but details not seen.

Remarks

P. batei is a typical member of the genus, and is closest to *P. maculata* Brenner & Oertli (1976) from the Hauterivian of the Algoa Basin. The latter has a concave VM, and has its posterior apex at about mid-height. *P. batei* is also similar to a species recorded as *Paijenborchellina* sp. 1 Swain by Damotte (1979) from the early–late Aptian of DSDP 402A (core 34/CC) on the continental slope in the northern Bay of Biscay. Comparison with Swain's (1976) figures suggests that Damotte's specimen is not conspecific, and probably not a *Paijenborchellina*, but rather belongs to *Procytherura*. It differs from *P. batei* in possessing weak longitudinal ribbing, especially in the anterior half.

Dimensions (mm)

	length	height	width
6038	0,45	0,23	
6039	0,43	0,25	
6040	0,49		0,16

Age and distribution

P. batei is known from the early–middle Albian of DSDP 330 (core 2–2/122–126 cm), and middle Albian of DSDP 327 (core 16–4/66–70 cm). It is rare (*c*. 3 % total ostracod population) in the former, and relatively abundant (18 %) in the latter.

Procytherura cf. *P. dinglei* Brenner & Oertli, 1976

Fig. 12D

Remarks

P. dinglei was recorded by Brenner & Oertli (1976) from the Hauterivian of the Algoa Basin (south-east Africa). Our material consists of one slightly damaged valve from the Falkland Plateau. Externally the specimen has a very similar outline and ornamentation to *P. dinglei*, including the rather irregular surface of the ventrolateral swelling in the posterior half of the valve. The only significant point of difference is the somewhat smoother shell surface of the anterior part of the valve in the DSDP specimen.

Interior details in *P.* cf. *P. dinglei* are not well preserved, but show a typical holoperatodont hinge, although there is a suggestion of crenulation on the posterior part of the LV ME (which may be due to abrasion). Brenner & Oertli (1976) did not record internal details in their topotypes.

Dimensions (mm)

	length	height
6041	0,45	0,25

On a length–height scattergram, this specimen plots precisely within the field defined by Brenner & Oertli's population (1976, fig. 27).

Age and distribution

P. cf. *P. dinglei* is known from a single LV in the middle Albian of DSDP 327 (core 16–6/126–130 cm) on the Falkland Plateau. *P. dinglei* is known only from the Hauterivian of the Algoa Basin.

Genus *Cytheropteron* Sars, 1866

Cytheropteron bispinosa sp. nov.

Fig. 13A–D

Derivation of name

Latin *bispinosa* (two spines): reference to two spines on the alae.

Holotype

SAM–PC6042, LV, DSDP 36/330, core 1–1/112–116 cm, early–middle Albian.

Paratypes

SAM–PC6043, RV, as above.
SAM–PC6044, LV, as above.
SAM–PC6045, LV, as above.

Diagnosis

Species with blunt alae that typically bear two short spines at their posterior ends.

Description

External features. Elongate ovate in lateral outline. AM rounded, somewhat truncated anteroventrally, acuminate PM, caudal process slightly upturned. DM and VM broadly convex, former has a prominent rim. Alae blunt and wedge-

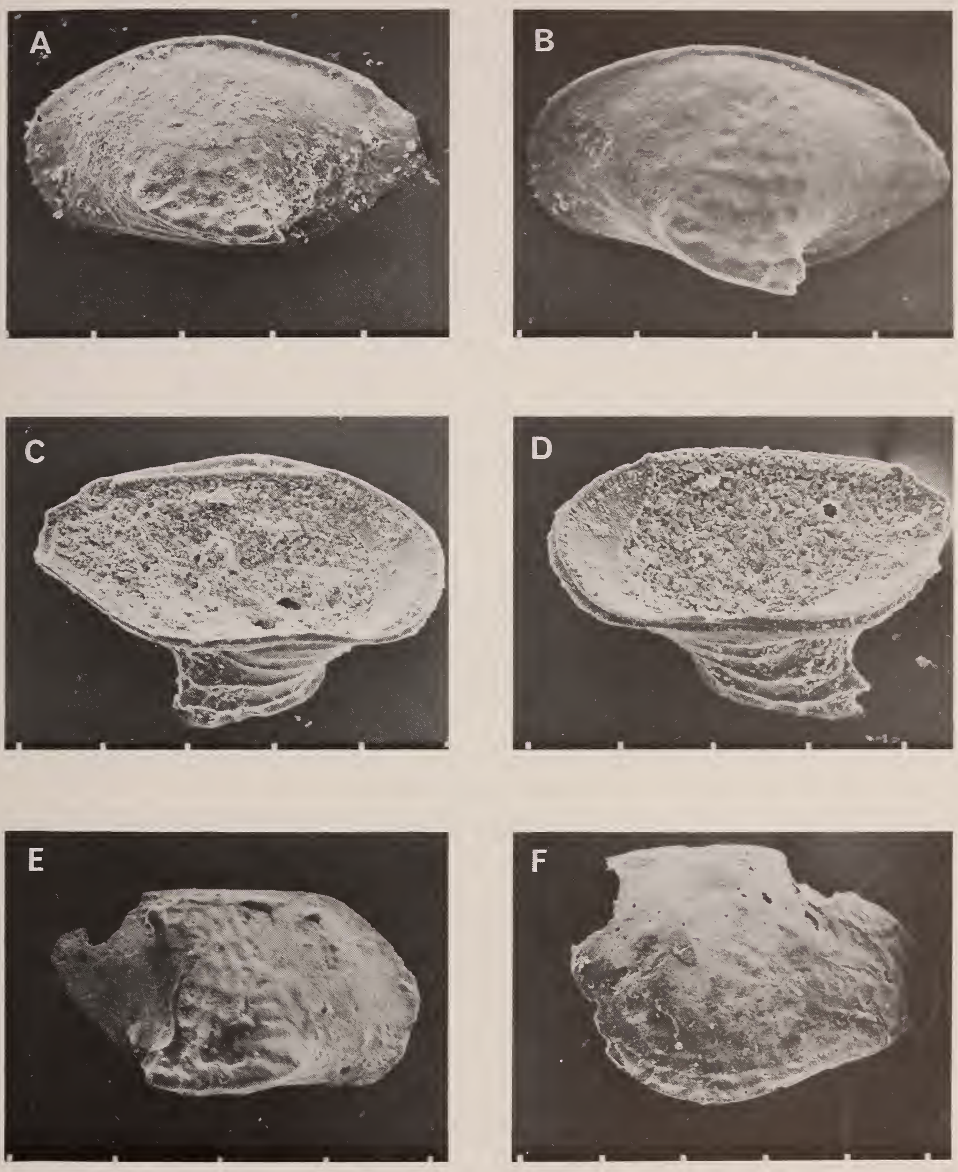


Fig. 13. A–D. *Cytheropteron bispinosa* sp. nov., DSDP 330, core 1–1/112–116 cm, early–middle Albian. A. Holotype, SAM–PC6042, LV. B. SAM–PC6044, LV. C. SAM–PC6045, LV, internal view. D. SAM–PC6043, RV, internal view. E. *Cytheropteron* sp. 327/18, SAM–PC6046, RV, DSDP 327, core 18–2/51–55 cm, middle Albian. F. *Cytheropteron* sp., SAM–PC6047, RV, TBD 1113, Agulhas Bank, Middle–Upper Albian.
Scale bars = 100 μ.

shaped with a short ribbed leading edge. Trailing edge bears two short, wide, sharp spines, one at the extremity, the other just inboard at the end of a narrow ventral surface rib. There are three other ribs on the ventral surface. Overall, valve surface smooth except for faint coarse reticulation on upper surface of alae.

Internal features. MA broad, MS not seen. Hinge typical of genus, with two smooth TE and crenulate ME.

Remarks

C. bispinosa resembles *C. (Aversovalva) mccomborum* Neale (1975) from the Santonian of western Australia, but the latter has trispinose alae and overall punctation.

Dimensions (mm)

	length	height
6042	0,43	0,23
6043	0,43	0,20
6044	0,35	0,18

Age and distribution

C. bispinosa ranges early–middle Albian in DSDP 330 (core 1/cc–112–116 cm), and middle Albian in DSDP 327 (core 18–2/51–55 cm to 16–1/55–59 cm) on the Falkland Plateau. It is recorded from five levels in these two boreholes, and is common in site 330 (10–13 %) and rarer in site 327 (3–6 %).

Cytheropteron sp. 327/18

Fig. 13E

Remarks

Two valves of a subquadrate species of *Cytheropteron* that has an asymmetrical, bluntly rounded AM and a more acuminate PM. The alae are blunt, with a thick leading edge. Ala shape is reminiscent of that of *C. bispinosa* sp. nov. but valve outline of the two species differs considerably.

Age and distribution

Ranges middle Albian in DSDP 327 (cores 18–2/51–55 cm to 16–6/126–130 cm) on the Falkland Plateau.

Cytheropteron sp.

Fig. 13F

Remarks

Dingle (1971: 396) listed this fragmentary specimen (as *Cytheropteron?* sp.) from sample TBD 1113 on the Agulhas Bank, but did not illustrate or give any details of it. An SEM photograph shows that it has a broad, keeled ala projecting almost to the AM. The rest of the valve is pitted and broken. The genus *Cytheropteron* is not well represented in the Lower and mid-Cretaceous of south-east Africa, with only one species (*C. (Infracytheropteron) persica* Brenner & Oertli) reported from the Upper Valanginian to Hauterivian of the Algoa Basin (*c.* 1%) (Brenner & Oertli 1976) and Outeniqua Basin (McLachlan *et al.* 1976*b*). The specimen illustrated here differs in both ala outline and ornamentation from *C. (I.) persica, C. bispinosa*, and *C.* sp. 327/18.

Age and distribution

Known only from the Middle–Upper Albian of the Agulhas Bank (sample TBD 1113).

Genus *Hemingwayella* Neale, 1975

Subgenus ***Parahemingwayella*** subgen. nov.

Derivation of name

Generic name *Hemingwayella* + 'para' to denote closeness of new taxon to genotype *H. (H.) ornata* Neale 1975.

Type species

H. (P.) barkeri sp. nov.

Diagnosis

Subgenus of *Hemingwayella* that is blind.

Remarks

Neale (1975) erected the genus *Hemingwayella* to accommodate a species that fell within the so-called *Paracytheridea* subgroup of Hanai (1957) but could not be placed within existing genera such as *Paracytheridea, Eucytherura*, and *Paracytheropteron*. The new subgenus *Parahemingwayella* is erected to accommodate three species that fulfill most of the prerequisites of Neale's diagnosis but differ on a few significant points. The most important is blindness, but there are also minor features such as a slightly flexed DM (including a distinctive kink in the hinge ME), and converging DM and VM. The considerable difference in age between the known species of the genus suggest that *H. (Parahemingwayella)* was ancestral to *H. (Hemingwayella)*.

Age and distribution

The subgenus *Parahemingwayella* is known only from the early to middle Albian of the Falkland Plateau, while the subgenus *Hemingwayella* is known only from the Santonian of western Australia.

Hemingwayella (Parahemingwayella) barkeri sp. nov.

Fig. 14A–C

Derivation of name

After Dr P. Barker, co-chief scientist of DSDP Leg 36 to the Falkland Plateau.

Holotype

SAM–PC6048, RV, DSDP 330, core 1/cc, early–middle Albian.

Paratype

SAM–PC6049, LV, as above.

Diagnosis

Species with two prominent ventrolateral processes.

Description

External features. Elongate, subtriangular in lateral view. AM broadly rounded, weakly spinose, PM small, bluntly rounded, slightly upturned. DM flexed at about mid-length, which in RV produces a posteriorly directed step. VM straight to weakly convex. DM and VM converge posteriorly. Highest point of valve over prominent anterior CA. Surface features dominated by a large, rounded, ribbed median–ventrolateral to subcentral process, and a more diffuse elliptical ribbed posteroventral swelling which is posteriorly directed. A prominent rib runs diagonally from the posterior CA, round the dorsal side of the subcentral process, and in some specimens, to the subcentral part of the AM. A second prominent rib skirts the ventral side of the subcentral process and passes across the crest of the posteroventral swelling. Several smaller longitudinal ribs occur in the ventral and posterior parts of the valve surface. Other areas are weakly reticulate and strongly punctate. There is a median sulcus.

Internal features. MA wide, MS not seen. Hinge in RV consists of sinuous, narrow, finely crenulate ME groove with narrow, smooth outward-projecting ATE and PTE.

Remarks

H. (P.) barkeri differs from *H. (H.) ornata* Neale in shape of DM and AM, and in having a continuation of the diagonal longitudinal rib to the posterior CA; in *H. (H.) ornata* this rib runs only to a mid-height position. Average length–height ratios for the two species are 1,52 (*ornata*) and 1,98 (*barkeri*).

Dimensions (mm)

	length	height
6048	0,32	0,15
6049	0,42	0,21

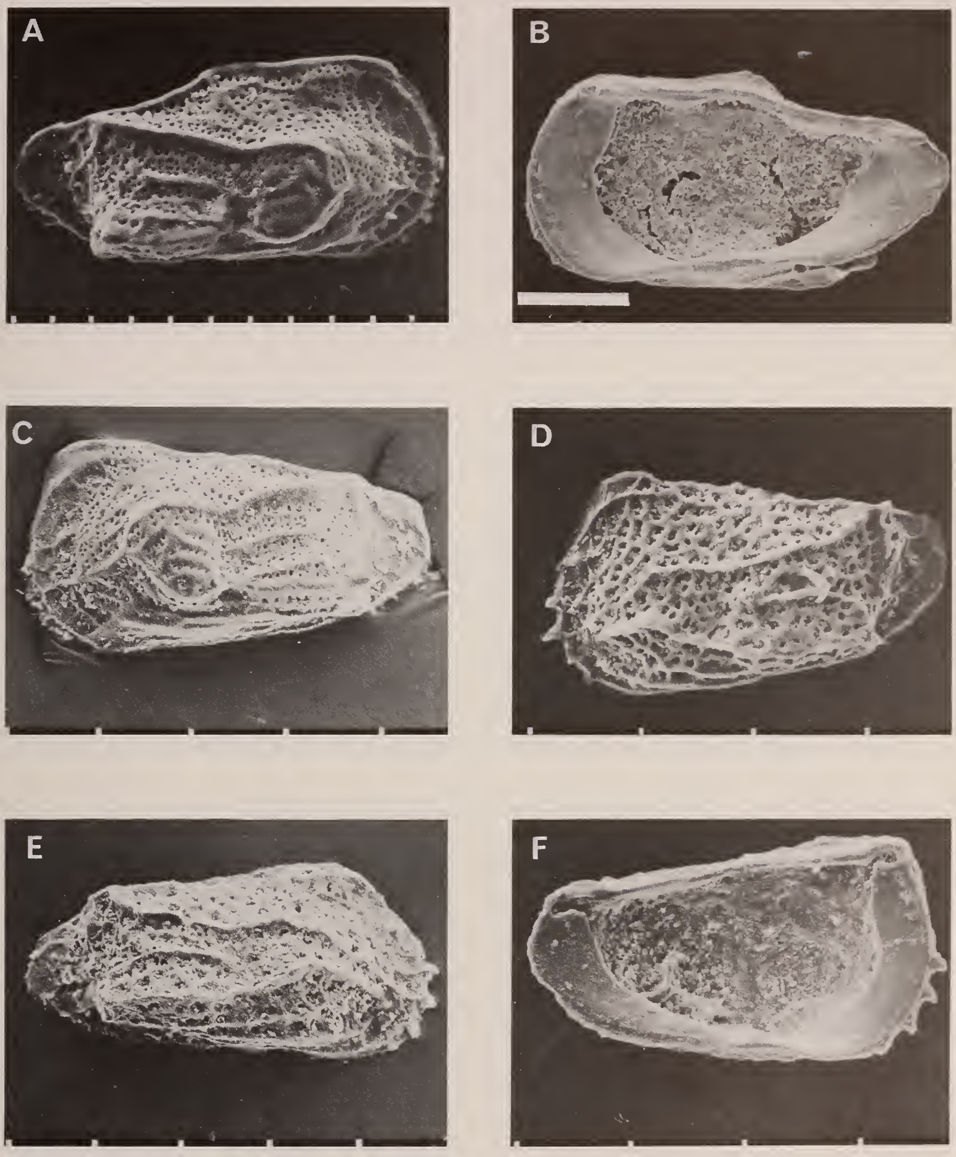


Fig. 14. A–C. *Hemingwayella (Parahemingwayella) barkeri* subgen. et sp. nov., DSDP 330, core 1/cc, early–middle Albian. A–B. Holotype, SAM–PC6048, RV. A. External view. B. Internal view. C. SAM–PC6049, LV. D–F. *Hemingwayella (Parahemingwayella) dalzieli* subgen. et sp. nov., DSDP 330, core 1, early–middle Albian. D. Holotype, SAM–PC6050, LV, core cutter. E. SAM–PC6051, RV, section 1/112–116 cm. F. SAM–PC6052, LV, core cutter, internal view.
Scale bars: A = 30 μ, others = 100 μ.

Age and distribution

H. (P.) barkeri is known from the early–middle Albian of DSDP site 330 (core 1/cc), and middle Albian of DSDP 327 (core 16–4/66–70 cm) on the Falkland Plateau, where it is a rare species (*c*. 3% at both sites).

Hemingwayella (Parahemingwayella) dalzieli sp. nov.

Figs 14D–F, 15A

Derivation of name

After Dr I. Dalziel, co-chief scientist of DSDP Leg 36 to the Falkland Plateau.

Holotype

SAM–PC6050, LV, DSDP 330, core 1/cc, early–middle Albian.

Paratypes

SAM–PC6051, RV, DSDP 330, core 1–1/112–116 cm, early–middle Albian.
SAM–PC6052, LV, DSDP 330, core 1/cc, early–middle Albian.
SAM–PC6053, RV, DSDP 330, core 1/cc, early–middle Albian.

Diagnosis

Species with subcentral process, coarsely spinose AM, valve surface coarsely reticulate with two prominent converging longitudinal ribs.

Description

External features. Elongate, subtriangular in lateral view. AM broadly rounded with a few sharp, stubby, almost hook-like spines, PM narrow and rounded. DM almost straight, slightly flexed at about mid-length. VM straight to slightly convex, DM and VM converge posteriorly. Subcentral process indistinct, but large and rounded, posteroventral process elongate and outlined by several longitudinal ribs. Surface features dominated by two narrow longitudinal ribs: one runs diagonally from the posterior CA to the dorsal side of the subcentral process, skirts it and continues to the AM; the other runs from the outer edge of the posteroventral process to the ventral side of the anteroventral process, is deflected dorsally across the crest of the anteroventral process, and continues parallel to the median rib to the AM area. A short posteromedian, and two ventral longitudinal ribs are also typically present. Highest point lies over the anterior CA. There is a shallow median sulcus.

Internal features. Reverse of the exterior median sulcus is well developed. MA wide, particularly posteriorly. MS not seen. NPC prominent. Hinge in LV consists of an ME bar with slight median flexing, and two small terminal elements that are wrapped round by the MA. RV structures are complementary. ME are probably crenulate.

Remarks

H. (P.) dalzieli is close to *H. (P.) barkeri*, but the former can be distinguished from the latter by its poorly developed subcentral process, its less-flexed DM, its more angular posterior CA, and the presence of two converging longitudinal ribs, the ventral one of which has a distinctive flexure at about quarter length. Average length–height ratios are: 1,99 (*barkeri*) and 1,91 (*dalzieli*) (Fig. 16).

Dimensions (mm)

	length	height
6050	0,34	0,20
6051	0,46	0,21
6052	0,35	0,19
6053	0,35	0,18

Age and distribution

H. (P.) dalzieli is known only from the early–middle Albian at DSDP site 330 (core 1/cc and 1–1/112–116 cm), where it is relatively abundant (*c.* 10% and 6%, respectively).

Hemingwayella (Parahemingwayella) reticulata sp. nov.

Fig. 15B–D

Derivation of name

Latin *reticulata* (reticulate): reference to ornamentation.

Holotype

SAM–PC6054, LV, DSDP 330, core 1/cc, early–middle Albian.

Paratype

SAM–PC6055, RV, as above.

Diagnosis

Reticulate species with well-developed mural spines.

Description

External features. Elongate, subtriangular. AM broadly rounded with several stout, short, frequently hooked spines, PM narrow, rounded. DM almost straight in LV, distinctly flexed in RV. VM straight, converges posteriorly with DM. Subcentral process very weakly developed, separated from a more prominent posteroventral process by a median sulcus. The latter process bears a few stubby spines. There is a well-developed spinose, conical process just below the posterior CA and a similar but smaller elevation at the anterior CA. Surface

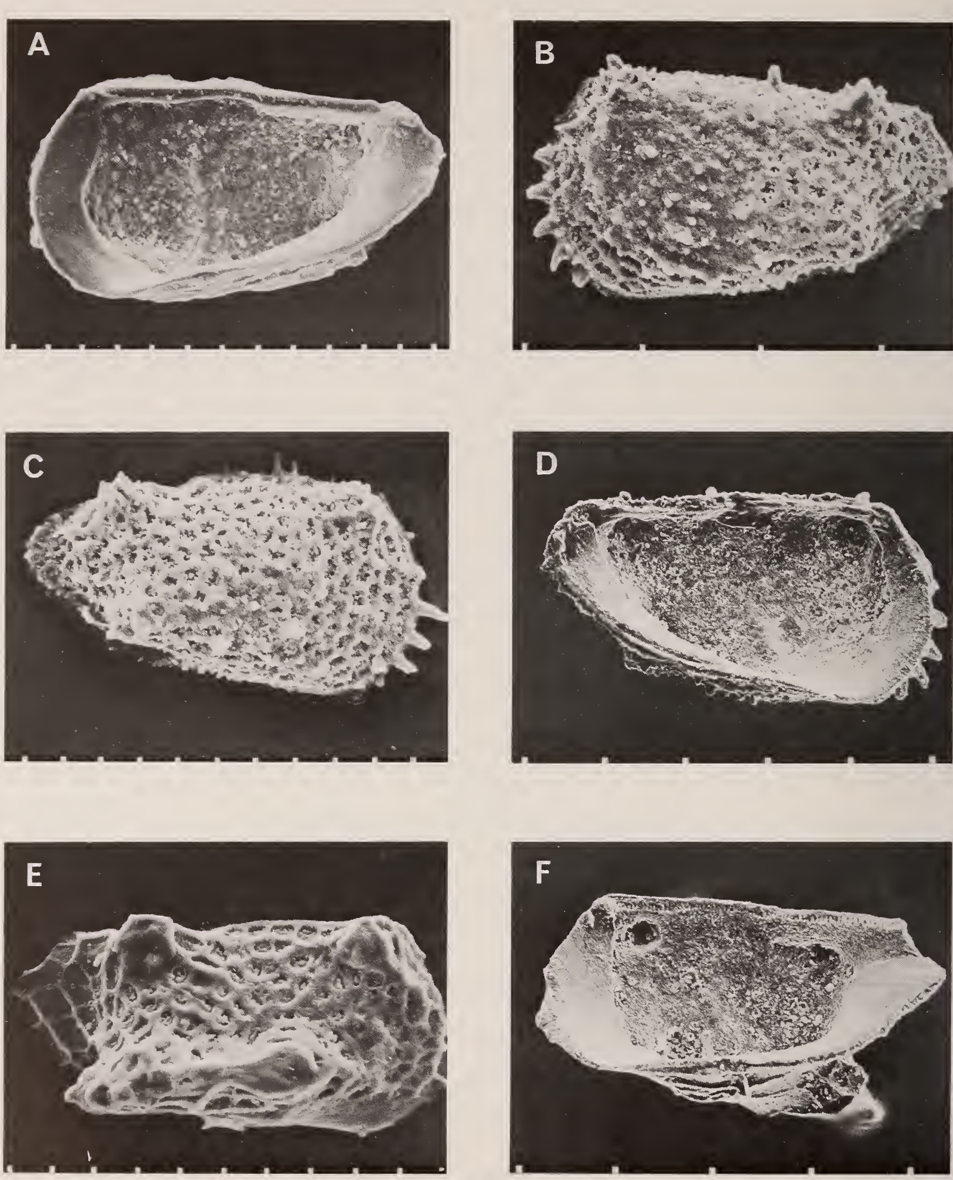


Fig. 15. A. *Hemingwayella (Parahemingwayella) dalzieli*, subgen. et sp. nov., SAM–PC6053, RV, DSDP 330, core 1/cc, early–middle Albian, internal view. B–D. *Hemingwayella (Parahemingwayella) reticulata,* subgen. et sp. nov., DSDP 330, core 1/cc, early–middle Albian. B, D. Holotype, SAM–PC6054. B. LV. D. Internal view. C. SAM–PC6055, RV. E–F. *Hemiparacytheridea ewingensis* sp. nov,. DSDP 330, core 1/cc, early–middle Albian. E. Holotype, SAM–PC6056, RV. F. SAM–PC6057, RV, internal view. Scale bars: A, C, E = 30μ, B, D, F = 100μ.

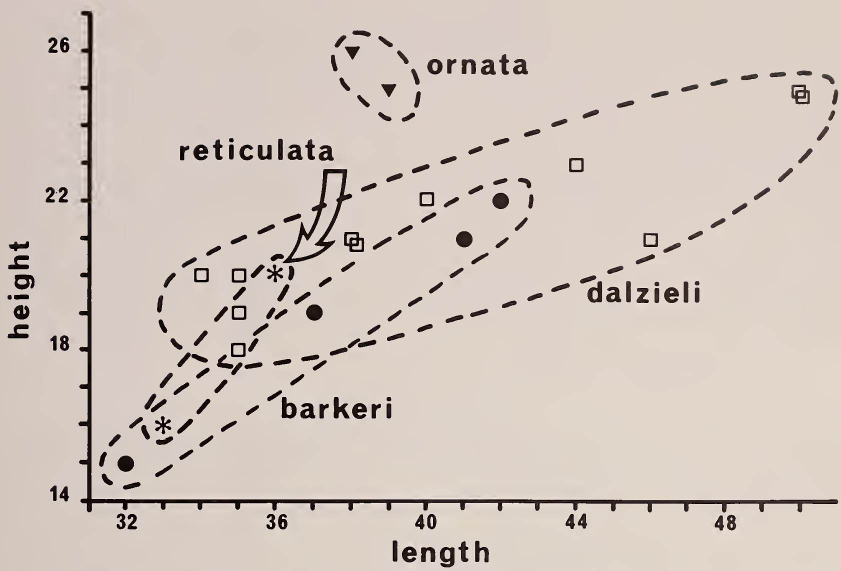


Fig. 16. Length v. height scattergram of adult specimens belonging to the genus *Hemingwayella* Neale, 1975 (scale ×10μ). Triangles: *H. (H.) ornata* Neale, 1975, western Australia, Santonian. Squares: *H. (P.) dalzieli* sp. nov., Falkland Plateau, early–middle Albian. Circles: *H. (P.) barkeri* sp. nov., Falkland Plateau, early–middle Albian. Stars: *H. (P.) reticulata* sp. nov., Falkland Plateau, early–middle Albian.

overall reticulate, with well-developed mural spines imparting a rough aspect to valve surface.

Internal features. MA moderate to broad. Median sulcus and processes on exterior surface have prominent counterparts in internal view. Hinge consists of a long flexed ME (bar in RV), and short, narrow TE. All elements are apparently smooth, but may be worn. MS not seen.

Remarks

H. (P.) reticulata is similar in outline to *H. (P.) dalzieli* but differs significantly in ornamentation: *reticulata* is reticulate overall with mural spines; *dalzieli* is reticulate, but also has several longitudinal ribs and does not have mural spines.

Dimensions (mm)

	length	height
6054	0,36	0,20
6055	0,33	0,16

Age and distribution

H. (P.) reticulata is known only from the early–middle Albian of DSDP 330 (core 1/cc and 1–1/112–116 cm) where it is rare (1–3%).

Genus *Hemiparacytheridea* Herrig, 1963

Hemiparacytheridea ewingensis sp. nov.

Fig. 15E–F

Derivation of name

Locality of type specimen on Maurice Ewing Bank, Falkland Plateau.

Holotype

SAM–PC6056, RV, DSDP 330, core 1/cc, early–middle Albian.

Paratype

SAM–PC6057, RV, as above.

Diagnosis

Species with large eye tubercle and large subcubic process over posterior CA. Surface coarsely reticulate.

Description

External features. Subquadrate in lateral outline. AM broadly rounded, PM asymmetrically pointed with apex above mid-height. DM and VM straight, converging posteriorly. There is a large eye-spot and a similarly shaped feature over posterior CA. The ala is prominent and extends foward via a ridge to a large swelling at about third length. Surface coarsely reticulate.

Internal features. MA wide both anteriorly and posteriorly. The inner valve surface has four large hollows corresponding to the protuberences on the exterior surface. MS not seen. Hinge in RV consists of a long, straight, finely crenulate ME groove and small rounded ATE. PTE not preserved.

Remarks

Externally, *H. ewingensis* bears a resemblance to *H. hemingwayi* Neale, 1975, from the Santonian of western Australia, but the latter is more elongate and has a higher PM apex. The hinge of our species is very similar to the type species (*H. occulta* Herrig, 1963, Upper Maastrichtian of Rugen Island, East Germany), but lacks the anterior ME enlargement, and has a less pronounced convergence of the DM and VM. Similarities with *H. challengeri* will be discussed below.

Dimensions (mm)

	length	height
6056	0,29	0,15
6057	*c*. 0,25	0,13

Age and distribution

H. ewingensis is a rare species (*c*. 2%) known only from the early–middle Albian at one horizon in DSDP 330 (core 1/cc) on the Falkland Plateau.

Hemiparacytheridea challengeri sp. nov.

Fig. 17A

Derivation of name

From the drilling ship *Glomar Challenger*, which drilled DSDP sites on the Falkland Plateau.

Holotype

SAM–PC6058, LV, DSDP 330, core 1–1/112–116 cm, early–middle Albian.

Diagnosis

Reticulate species with prominent longitudinal median rib, a pointed symmetrical PM, and a pyramid-shaped posterodorsal process.

Description

External features. In lateral view elongate quadrate, broadly rounded AM and symmetrically pointed PM. DM straight, but deflected at anterior CA over prominent eye-spot. There is a large pyramid-shaped process at the posterior CA, which has a narrow anteriorly projecting ridge that partially obscures the DM in lateral view. A ventrolateral ala terminates in a blunt spine and has a thick leading edge that carries forward as a curved rib and crosses a swelling at about third length. Central part of valve surface is coarsely reticulate and crossed by a longitudinal median rib that runs from in front of the eye-spot to about two-thirds valve length.

Internal features. MA wide, though not seen clearly. MS not seen. Hinge in LV consists of a long, straight crenulate ME bar, which thickens at its anterior end and possibly at its posterior end. There is an ATE socket, but PTE socket not observed.

Remarks

H. challengeri differs from the type species and from *H. ewingenis* in having a relatively subdued ventrolateral swelling and a symmetrically pointed PM. It is closely related to *H. ewingensis*, but differs further in aspects of ornamentation by possessing a longitudinal median rib and anteriorly projecting ribs from both the posterior CA and ala. In *H. challengeri* the line of greatest length is closer to mid-height.

Damotte (1979) recorded specimens identified as *Paranotacythere* sp. 69 from the Aptian (Foraminifera zone MC 22) of DSDP 400A in the northern Bay of Biscay. Her illustrations (plate 1 (figs 6–7)) bear a considerable resemblance to *H. challengeri*, which, taken in conjunction with the doubtful generic assignment for her material (no internal views), suggests that the North Atlantic species may also belong to *Hemiparacytheridea*.

Dimensions (mm)

	length	height
6058	0,28	0,15

Age and distribution

H. challengeri is known only from the early–middle Albian of DSDP 330 (core 1/cc) on the Falkland Plateau.

Genus *Pedicythere* Eagar, 1965

Pedicythere falklandensis sp. nov.

Fig. 17B

Derivation of name

Falkland Plateau, site of DSDP boreholes from which type specimens were obtained.

Holotype

SAM–PC6059, LV, DSDP 330, core 1/cc, early–middle Albian.

Paratype

SAM–PC6060, LV, DSDP 330, core 1–1/112–116 cm, early–middle Albian.

Diagnosis

Species with drawn-out posterior area and pointed PM. Greatest length lies along DM.

Description

External features. AM broadly rounded, separated from DM by a small step. PM drawn out, highly asymmetric, apex in line with DM, slightly upturned dorsally, posteroventral part of PM slopes up strongly, and bears a broad spine. DM straight and coincides with line of greatest length. VM broadly convex, partially obscured in lateral view by ala. Ventrolateral area bears a large hollow spine that projects almost at right angles to valve surface. This spine has a short leading-edge ridge. Anterior area compressed and separated from rest of valve by a low ridge running in a curved line from the anterodorsal margin step to the ventral surface under the ala. DM margin obscured by a delicate frieze-like rim.

Internal features. Poorly seen. In LV hinge ME consists of a long, slightly sinuous narrow bar, PTE is a narrow crenulate socket, ATE is a rounded ?smooth hollow. MS and MA not seen clearly.

Remarks

P. falklandensis is closest to *P. fragilis* Dingle, 1981, from the Maastrichtian of Zululand, but differs in having a more acuminate posterior area, a less posteriorly deflected ala, and lacking the ala leading-edge extension to the AM.

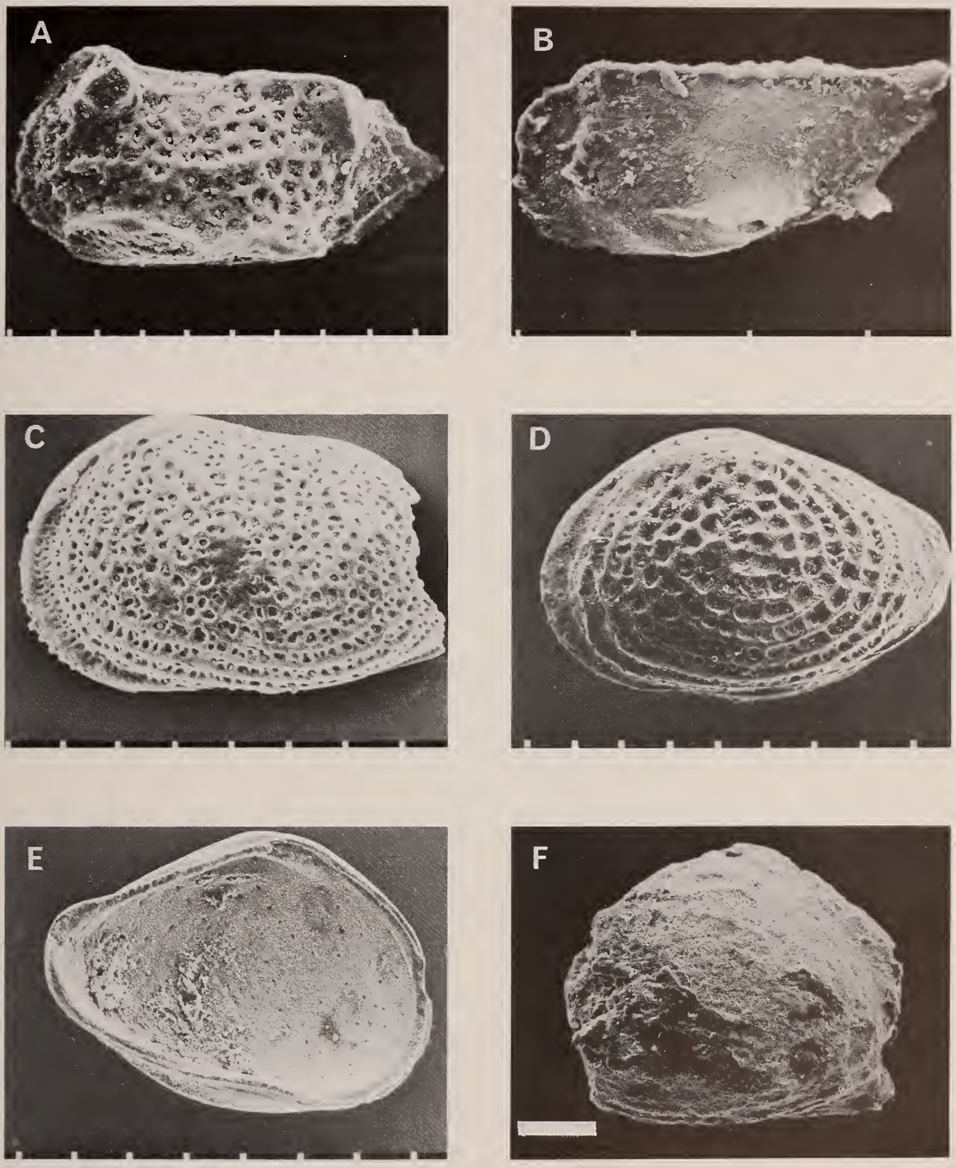


Fig. 17. A. *Hemiparacytheridea challengeri* sp. nov., holotype, SAM–PC6058, LV, DSDP 330, core 1–1/112–116 cm, early–middle Albian. B. *Pedicythere falklandensis* sp. nov., holotype, SAM–PC6059, LV, DSDP 330, core 1/cc, early–middle Albian. C. *Majungaella* cf. *M. queenslandensis* Krömmelbein, 1975, LV, TBD 1113, Middle–Upper Albian. Originally illustrated by Dingle (1971, fig. 4) and designated MG–3–1–9, this specimen was destroyed during SEM preparation. D–E. *Majungaella nematis* Grekoff, 1963, locality 171–1, Mlambongwenya Spruit, Zululand, Aptian IV. D. SAM–PC6061, LV. E. SAM–PC6062, LV, internal view. F. *Majungaella ?hemigymnae* Brenner & Oertli, 1976, SAM–PC6063, LV of carapace, locality 152–5, Mkuze, Zululand, Aptian IV.
Scale bars: A = 30 μ, others = 100 μ.

P. australis Neale, 1975, from the Santonian of western Australia has different PM and AM outlines, and has a ventrally directed ala spine.

Dimensions (mm)

	length	height
6059	0,32	0,17
6060	0,38	0,22

Age and distribution

P. falklandensis is known only from the early–middle Albian at DSDP site 330 (core 1/cc and 1–1/112–116 cm), where it is rare (*c.* 1% total ostracod population).

Family **Progonocytheridae** Sylvester-Bradley, 1948

Subfamily Progonocytherinae Sylvester-Bradley, 1948

Genus *Majungaella* Grekoff, 1963

This taxon is one of the characteristic elements of the South Gondwana Upper Jurassic to mid-Cretaceous ostracod province, extending from Argentina via the Falkland Plateau, South and east Africa, and India, to Australia.

Majungaella cf. *M. queenslandensis* Krömmelbein, 1975

Figs 17C, 18

Majungaella sp. A Dingle, 1971: 400–401; fig. 4.

Remarks

Originally compared to *M.* cf. *nematis* by Dingle (1971), this species is probably closer to *M. queenslandensis* on the basis of its finer reticulation pattern, and small anterodorsal marginal spines. Its MS pattern consists of four

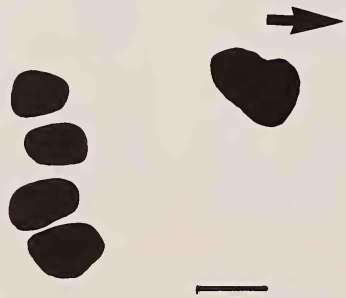


Fig. 18. Muscle scars of *Majungaella* cf. *M. queenslandensis*, TBD 1113, Agulhas Bank, Middle–Upper Albian. MG-3-1-9 of Dingle (1971, fig. 4) and Figure 17C (this paper). Scale bar = 30 μ.

rounded adductors and a rounded anterior scar (Fig. 18). During SEM preparation, the only good specimen (illustrated by Dingle, 1971, MG-3-1-9) was unfortunately crushed. The specimens illustrated by Krömmelbein (1975) have a slightly coarser reticulation than the Agulhas Bank material.

Age and distribution

M. cf. *queenslandensis* is known only from samples TBD 1113 and 1266 from the Alphard Formation of the Agulhas Bank, which have been dated as Middle–Upper Albian and Upper Aptian–Albian, respectively (see *Introduction*). *M. queenslandensis* was recorded by Krömmelbein (1975) from the Albian–Cenomanian Allaru Mudstone of the Great Artesian Basin, south-western Queensland, Australia.

Majungaella nematis Grekoff, 1963

Fig. 17D–E

Majungaella nematis Grekoff, 1963: 1744: pl. 5 (fig. 141–145), pl. 9 (figs 213–232). Sigal, 1974: pl. 1 fig. 4a–b. Brenner & Oertli, 1976: 501–502, pl. 5 (fig. 11–12). McLachlan *et al.*, 1976*b*: 346, fig. 15 (14–15). Guha 1976: 87, pl. 3 (fig. 23a–c).
Neocythere (N.) uitenhagensis Dingle, 1969: 152–153, fig. 11, pl. 9a–c.
Novocythere santacruziana Rossi de Garcia, 1972: in Malumian *et al.*: 271, pl. 1(7).

Remarks

Specimens of *M. nematis* from Zululand show no significant morphological differences to material from the Algoa–Outeniqua basins in the southern Cape or from other Gondwanide localities, indicating that this species exhibited intraspecific stability over its wide geographical and time ranges.

Age and distribution

M. nematis is known to have the following distributions in time and space:

1. Portlandian to Valanginian in the Majunga Basin of Madagascar (Grekoff 1963).
2. Upper Valanginian to Hauterivian, Lower Sundays River Formation, Outeniqua–Algoa basins (Dingle 1969; Brenner & Oertli 1976; McLachlan *et al.* 1976*b*).
3. ?Portlandian, Brenton Beds, Knysna–Outeniqua Basin (McLachlan *et al.* 1976*b*).
4. ?Hauterivian to Barremian in Santa Cruz Province, Argentina (Malumian *et al.* 1972).
5. Aptian IV to Cenomanian II, Makatini and Mzinene formations in the Mkuze, Mlambongwenya Spruit, and Ndumu areas of Zululand.
6. Early Cretaceous (860–755 m) of the Banni borehole, Rann of Kutch, India (Guha 1976).
7. 'Neocomian', DSDP site 249 (Mozambique Ridge) (core 27–3/26 cm) (Sigal 1974).

This list suggests that *M. nematis* was widely distributed in southern Gondwana during mid-Mesozoic times (Argentina to India), while its total temporal range was Portlandian to Cenomanian II. This is also its time range in southern Africa.

In Zululand *M. nematis* forms only a minor element of the ostracod faunas, but in the Algoa Basin it reached 7 per cent of the total population (Dingle 1982), and Grekoff (1963) notes that in the Majunga Basin of Madagascar it is 'common' and 'rare' in the Portlandian and Valanginian, respectively.

Majungaella ?hemigymnae Brenner & Oertli, 1976

Fig. 17F

Majungaella hemigymnae Brenner & Oertli, 1976: 504–505, pl. 6 (fig. 1–4), pl. 8 (fig. 5). McLachlan *et al.*, 1976*b*: 364, fig. 15 (17).

Remarks

A fragmentary carapace with longitudinal ribbing confined to the ventral part of the lateral surface. Outline and ornamentation very similar to Brenner & Oertli's species, but comparison of critical posterior areas not possible.

Age and distribution

Known only from the Makatini Formation (Aptian IV) at Mkuze, Zululand (locality 152–7). *M. hemingymnae* has been reported from the Lower Sundays River Formation of the Algoa Basin (Hauterivian) (Brenner & Oertli 1976), and from the Lower Sundays River and Kirkwood formations (?Berriasian to Valanginian) of the Outeniqua Basin and Brenton Beds (?Portlandian to Berriasian) at Knysna (McLachlan *et al.* 1976*b*).

Majungaella? sp. 327/16

Fig. 19A–C

Remarks

One LV of a progonocytherid with *Majungaella*-like aspect. Differs from previously described species of this genus in being more acuminate posteriorly, and having wider MA. The hinge appears to be antimerodont, with a large accommodation groove, but is poorly preserved. MS well seen: consist of a V-shaped frontal scar and four oval posterior scars in a vertical row.

Age and distribution

Recorded from middle Albian at DSDP site 327 (core 16–6/126–130 cm) on the Falkland Plateau.

Genus ***Pongolacythere*** gen. nov.

Derivation of name

Pongola, river valley location of holotype, plus generic appellation *cythere*.

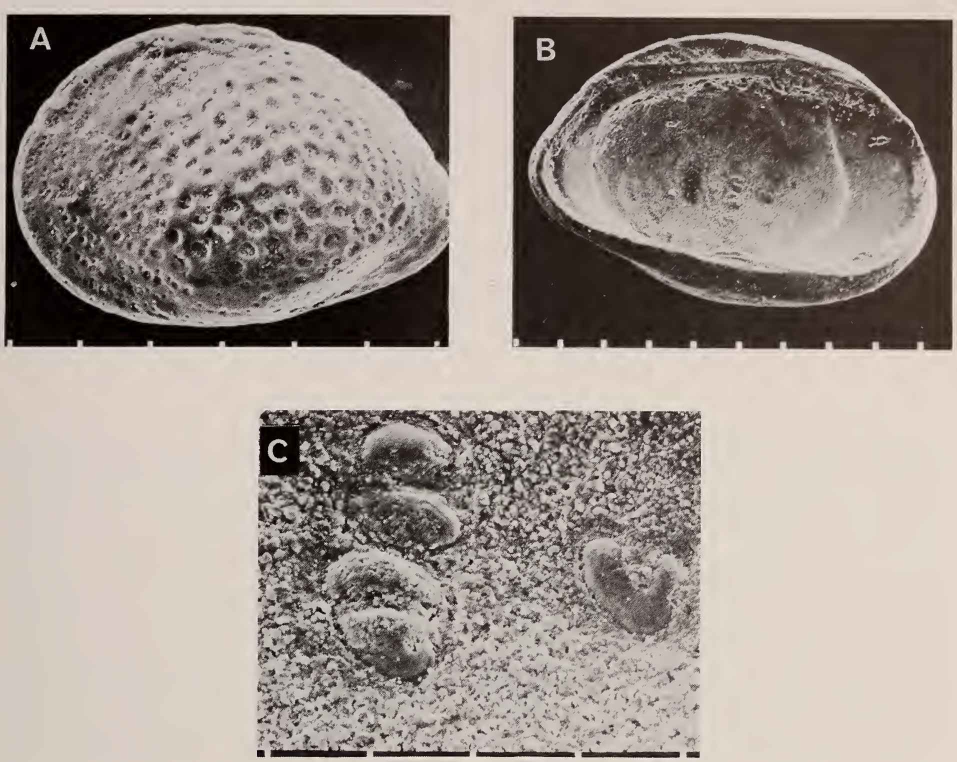


Fig. 19. A–C. *Majungaella?* sp. 327/16, SAM–PC6064, LV, DSDP 327, core 16–6/126–130 cm, middle Albian. A. Lateral view. B. Internal view. C. Muscle scars. Scale bars: A–B = 100 μ, C = 30 μ.

Type species

Pongolacythere striata sp. nov.

Diagnosis

Progonocytherid with an elongate carapace, round AM and PM. Hinge paramphidont. MA anteriorly narrow with about ten short RPC. MS probably consist of V-shaped anterior scar and curved row of four adductors. Lacks eyespots, SCT, and prominent longitudinal ridges.

Remarks

Although the hinge structure, lack of prominent longitudinal ridges, eyespots and SCT suggest an assignment to the Progonocytheridae, the overall shape of this new genus is not typical of the subfamily, and the placement must be considered provisional.

Pongolacythere has similarities to several genera, but differs from them on various points: *Acanthocythere* Sylvester-Bradley, 1948 (Bathonian of England) has eye-spots and a lobodont hinge; *Posteroprotocythere* Mandelstam, 1958 (Lower Jurassic to Upper Cretaceous of western and south-eastern Europe and south-western Asia) has an entomodont hinge and an outline reminiscent of *Protocythere*; and *Mosaeleberis* Deroo, 1966 (Upper Cretaceous to Lower Tertiary of Europe) has an SCT, prominent longitudinal ridges and numerous (about thirty) anterior RPC. As far as African localities are concerned, it bears some resemblance to *Mandwacythere* Bate, 1975 (Portlandian of Tanzania), but this genus has a lophodont hinge and anterior vestibules. Bate (in Bate & Bayliss 1969) records four specimens of an apparently blind elongate species with fine longitudinal lateral ribs (Genus A from the Albian of Tanzania). He does not give an additional description, but from his illustration (pl. 5 (fig. 16)), this species could well belong within the genus *Pongolacythere*.

Age and distribution

So far known only from the Aptian IV to Albian III of northern Zululand, but may occur in the Albian of Tanzania (as Genus A of Bate, in Bate & Bayliss 1969).

Pongolacythere striata sp. nov.

Figs 20A–E, 21

Derivation of name

Latin *striatus* (fine line): reference to surface ornamentation of fine ribbing.

Holotype

SAM–PC6065, RV, locality 171–1, Makatini Formation, Mlambongwenya Spruit, Aptian IV.

Paratypes

SAM–PC6066, LV, as above.
SAM–PC6067, RV, as above.

Diagnosis

Species with ornamentation of fine longitudinal ribbing and reticulation, with foveolate intercostal areas.

Description

External features. Elongate, with RV AM asymmetrically rounded. LV AM broadly rounded and more symmetrical. PM rounded, slightly tapering. DM and VM almost straight and parallel; DM in LV has rounded elevation over CA. Surface ornamented with numerous fine longitudinal ribs converging somewhat towards anterior end. Posterior area is delicately reticulate. Intercostal areas have fine foveolate ornamentation. There is no SCT.

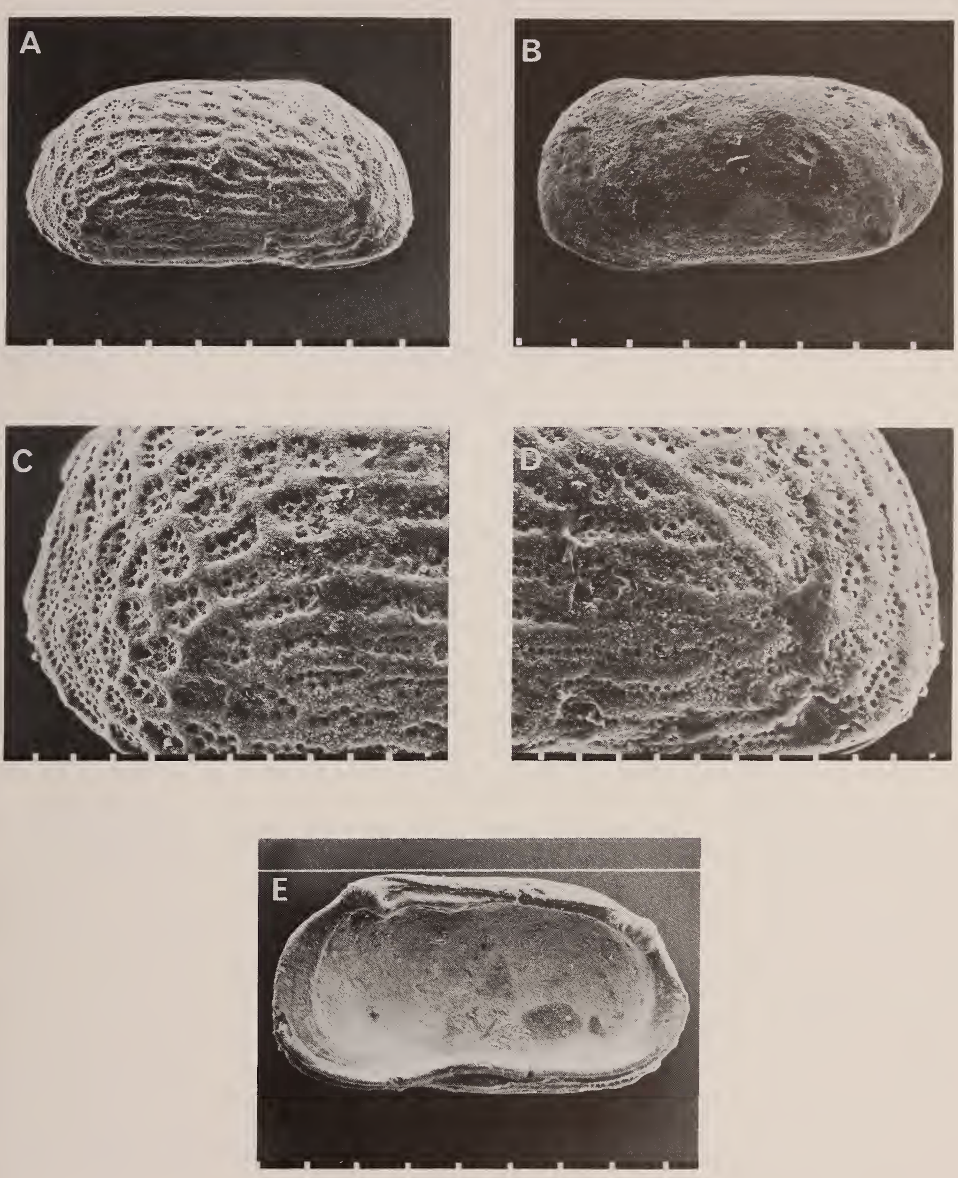


Fig. 20. A–E. *Pongolacythere striata* gen. et sp. nov., locality 171–1, Mlambongwenya Spruit, Zululand, Aptian IV. A, C–E. Holotype, SAM–PC6065, RV. A. External lateral view. C. Detail posterior area. D. Detail anterior area. E. Interior view. B. SAM–PC6066, LV. Scale bars: A–B, E = 100 μ, C–D = 30 μ.

Fig. 21. Muscle scars of *Pongolacythere striata* gen. et sp. nov., SAM–PC6067, LV, locality 171–1, Mlambongwenya Spruit, Zululand, Aptian IV. Scale bar = 30 μ.

Internal features. MA moderately wide, few (*c.* 10) straight, simple RPC anteriorly. Hinge paramphidont: in RV ATE consists of a large denticulate process, PTE a similar feature, which is highest posteriorly. ME smooth: consists of a long, narrow groove and a small, rounded anterior peg. No unworn LV hinges seen. MS not well preserved, apparently consist of a V-shaped anterior scar (may be subdivided and accompanied by two further scars dorsally), and four elliptical adductors in a curved row.

Remarks

Externally *P. striata* bears some resemblance to *Mosaeleberis interrupta* (Bosquet 1847) (Maastrichtian, western Europe), the type species of *Mosaeleberis* Deroo, 1966, but differs in lacking a prominent median longitudinal rib and an SCT. In addition, the DM and VM of *M. interrupta* converge posteriorly. *Mandwacythere striata* Bate, 1975 (Upper Jurassic, Tanzania) has a similar shape and ornamentation, but differs in the structure of its hinge and MA.

Dimensions (mm)

	length	height
6065	0,75	0,38
6066	0,72	0,34
6067	0,76	0,35

Age and distribution

This species is known to range Aptian IV to Albian III in the Mkuze and Mlambongwenya areas of northern Zululand.

Subfamily Protocytherinae Lubimova, 1955

Genus *Arculicythere* Grekoff, 1963

This is another taxon of the family Progonocytheridae that is typical of the Lower to mid-Cretaceous of the South Gondwana ostracod province. It has been recorded from the Falkland Plateau, Agulhas Bank, Madagascar, and off north-western Australia, and although Grekoff (1963) recorded it ranging Portlandian to Valanginian in Madagascar, it appears to be most abundant in the Albian of the Falkland Plateau, Agulhas Bank, and north-western Australia. Swain (1976) tentatively identified two valves as *Arculicythere?* sp. from the late Aptian–early Cenomanian of DSDP site 144 (core 5–1/3–9 cm) (north-west of Cape Verde Islands), but his illustrations are not typical of the genus, and probably do not belong to it. No unequivocal records of *Arculicythere* therefore exist outside the south Gondwanide oceans.

Arculicythere tumida Dingle, 1971

Figs 22A–F, 23A–D

Arculicythere tumida Dingle, 1971: 401–403, fig. 5.
Arculicythere? sp. A Oertli, 1974: 947, pl. 4 (figs 1–11), pl. 5 (figs 1–12).

Remarks

In the original diagnosis, Dingle (1971) mentioned an amphidont hinge. This was a typographical error, and in the accompanying description, it was correctly stated as antimerodont. SEM pictures of topotypes are included herein to supplement the original descriptions. Illustrations of material from the Falkland Plateau are indistinguishable from those of Agulhas Bank specimens. The specimens illustrated by Oertli (1974) from off-shore north-western Australia are somewhat more elongate, but otherwise fit well into the species.

The holotype and two paratypes of *A. tumida* originally designated MG–3–1–1, MG–3–1–2, and MG–3–1–3 respectively by Dingle (1971), have now been placed in the South African Museum under catalogue numbers SAM–PC–6068, 6069, and 6070 respectively. Figure 24 shows a length–height scattergram.

Age and distribution

A. tumida is known to have the following ranges and distribution:

1. Sample TBD 1113, Alphard Formation, Agulhas Bank (Middle–Upper Albian) (Dingle 1971).
2. Early to late Albian (cores 21–4/130–134 cm to 15–2/132–136 cm) at DSDP site 327, and early–middle Albian (cores 2–2/122–126 cm to 1–1/112–116 cm) at DSDP site 330, Falkland Plateau.
3. Middle–Upper Albian (cores 17–2/21–23 cm to 12–2/60–62 cm) DSDP site 259, north-west of Perth, western Australia (Oertli 1974).

This suggests that *A. tumida* was widely distributed in the proto southeastern Atlantic and southern Indian oceans in ?early to late Albian times. An interesting aspect of its distribution in these three areas is that it typically forms a major element of the total ostracod population: Agulhas Bank (46%); Falkland Plateau (typically between 22% and 38%); and western Australia (63% of all Albian ostracods recorded at site 259), where it is locally the sole species. In

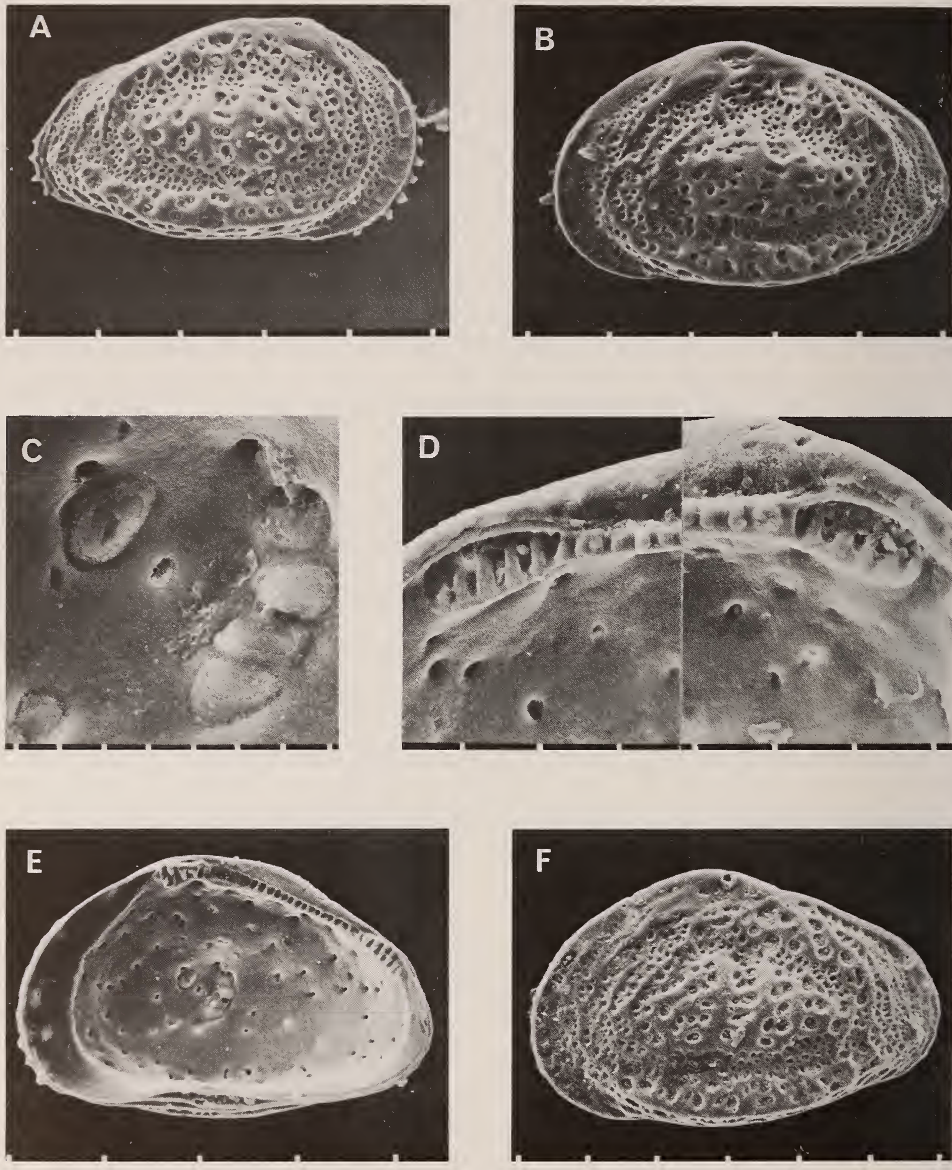


Fig. 22. A–F. *Arculicythere tumida* Dingle, 1971. A–E. TBD 1113, Agulhas Bank, Middle–Upper Albian. A. SAM–PC6071, RV. B. SAM–PC6072, LV. C, E. SAM–PC6073, RV. C. Muscle scars. E. Interior view. D. SAM–PC6129, LV. Details of ATE and PTE of hinge—composite photograph, whole of ME not shown. F. SAM–PC6074, LV, DSDP 330 core 1/cc, early–middle Albian.

Scale bars: A–B, E–F = 100μ, C = 10μ, D = 30μ.

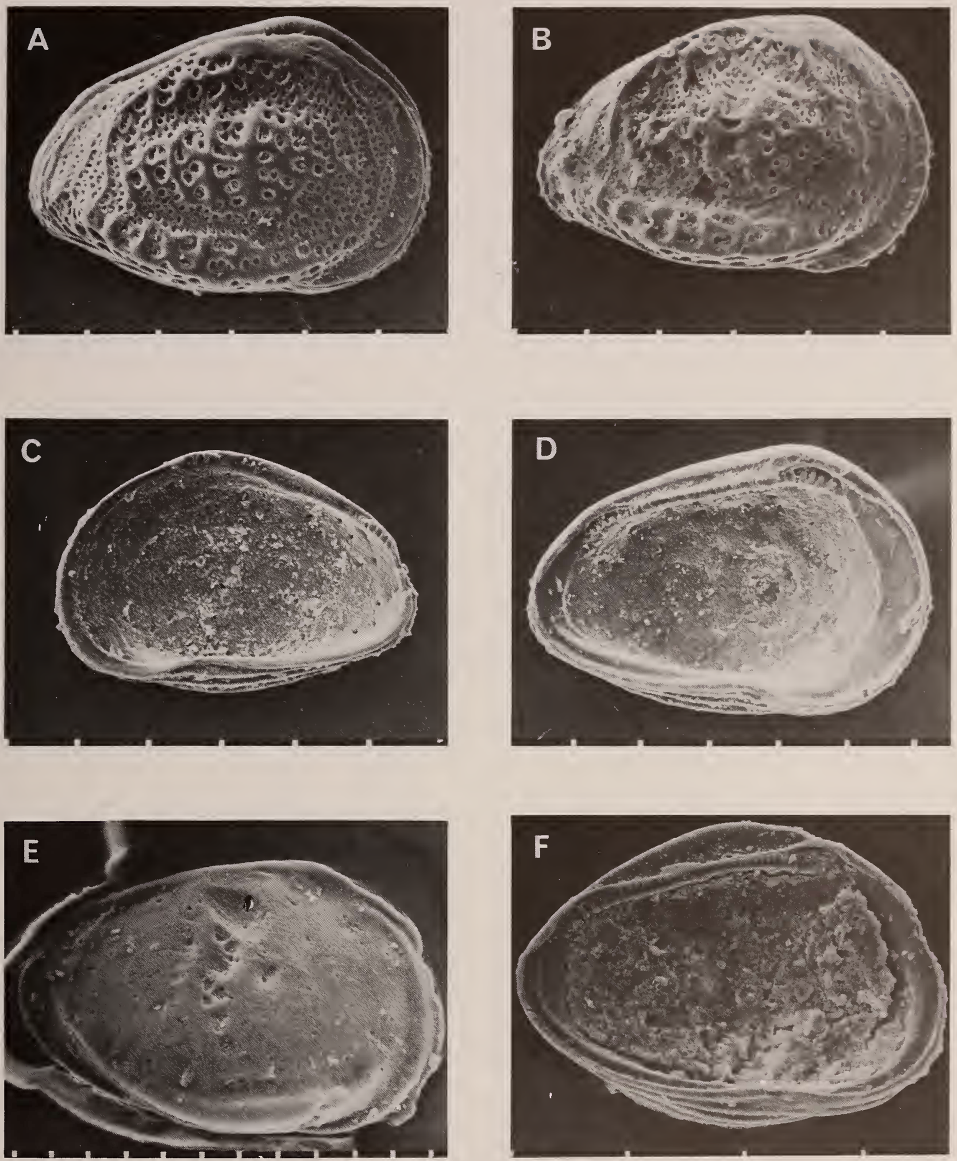


Fig. 23. A–D. *Arculicythere tumida* Dingle, 1971. A, C–D. DSDP 330, core 1/cc, early–middle Albian. A. SAM–PC6075, RV. C. SAM–PC6077, RV, internal view. D. SAM–PC6078, LV, internal view. B. SAM–PC6076, RV, DSDP 327, core 15–2/132–136 cm, late Albian. E–F. *Collisarboris? stanleyensis* sp. nov., DSDP 327, core 15–2/132–136 cm, late Albian. E. Holotype, SAM–PC6079, RV. F. SAM–PC6080, LV, internal view.

Scale bars: A–D, F = 100μ, E = 30μ.

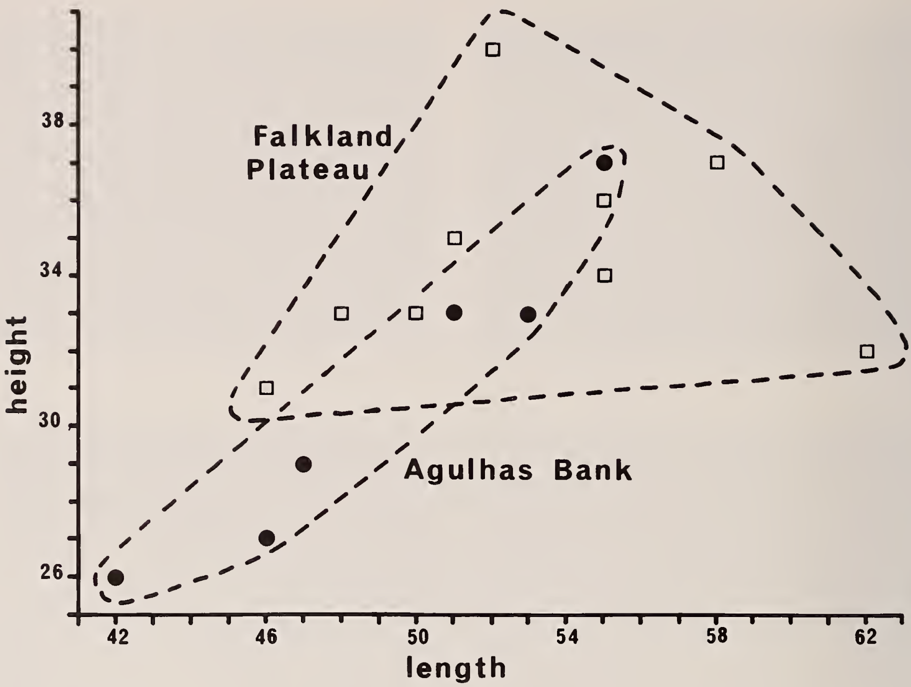


Fig. 24. Scattergram of length v. height for adult specimens of *Arculicythere tumida* from the Agulhas Bank (dots) and Falkland Plateau (squares) (scale ×10 μ).

addition, both the DSDP localities probably represent deposition in water depths between 100 and 200 m, and we suspect that this may also have been the case on the Agulhas Bank (see *Discussion*).

Family **Collisarborisidae** Neale, 1975

Genus *Collisarboris* Neale, 1975

Collisarboris? stanleyensis sp. nov.

Figs 23E–F, 25, 26A

Derivation of name

Port Stanley, capital of the Falkland Islands.

Holotype

SAM–PC6079, RV, DSDP 327, core 15–2/132–136 cm, late Albian.

Paratypes

SAM–PC6080, LV, as above.
SAM–PC6081, RV, as above.

Diagnosis

Blind species, with compressed AM area and prominent pits over MS on valve exterior.

Description

External features. Ovate outline, symmetrical, broadly rounded AM with narrow frilled border and low AM rim. Anterior part of valve compressed. PM roundly acuminate, apex at about mid-height. DM straight in RV, convex in LV. VM slightly convex, but hidden in lateral view by broad ventral overhang. Anterior CA fairly prominent in RV, with a depression below it. Lateral surface mostly smooth, but there are a few scattered large puncta and numerous fine puncta, and in the vicinity of a slight median sulcus the valve surface is often weakly and coarsely reticulate. MS pattern shows through in this sulcus as a line of pits. The wide ventral overhang has a broad keel along its outer edge.

Internal features. Hinge antimerodont: in RV the TE have large denticles, and the ME has finer crenulation; LV has a narrow accommodation groove and a prominently overhanging ledge, RV has a high concave elevation that receives the RV ledge. MA not clearly seen, nor MS from the inside, but external impressions indicate a long curved row of five posterior scars of which P2–P4 are partially subdivided, and a group of three smaller, rounded anterior scars (Fig. 25).

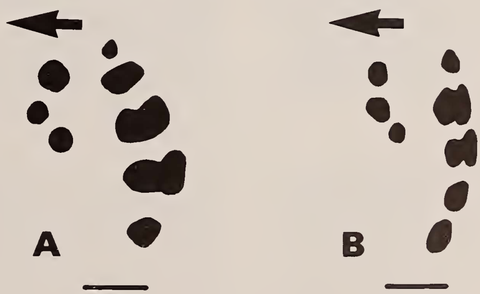


Fig. 25. Muscle scars of *Collisarboris? stanleyensis* sp. nov. A. DSDP 327, core 15–2/132–136 cm, late Albian. B. DSDP 327, core 16–4/66–70 cm, middle Albian.
Scale bars = 30 μ.

Remarks

Several aspects of *C? stanleyensis* do not fit precisely within Neale's (1975) original concept of the genus *Collisarboris* but, because it was based on one species, some extension may be considered permissible. The new species is blind, whereas the genotype *C. cooki* has small eye-spots and, while the hinges of *C? stanleyensis* and *C. cooki* are both characterized by accommodation grooves and shelves, it is the LV in the former and the RV in the latter that are the more imposing structures. The MS pattern in the Falkland Plateau species has five posterior scars compared to the four reported by Neale (1975), but the MS were obviously not well preserved in Neale's material because he could not see the frontal scars. Despite these differences, our specimens have the ovate, neocytherid shape, an antimerodont hinge, a carinate ala, and a smooth to punctate shell surface. Rather than erect a new higher taxon, it is felt that these similarities warrant tentative assignment to Neale's genus.

Dimensions (mm)

	length	height
6079	0,33	0,22
6080	0,36	0,26
6081	0,41	0,26

Age and distribution

C? stanleyensis is a rare to tertiary component of the middle (3%) to late Albian (6%) strata at two levels in DSDP 327 (cores 16–4/66–70 cm, and 15–2/132–136 cm) on the Falkland Plateau.

Genus *Sphaeroleberis* Deroo, 1966

Sphaeroleberis? sp. A

Fig. 26B

Remarks

One carapace and two valves of a species tentatively placed in *Sphaeroleberis*. Lack of good hinge views precludes a more definite assignment. In Europe the genus is typical of the Maastrichtian, and Neale (1977) has reassigned North American Campanian species to it. Bate (in Bate & Bayliss 1969) records *Sphaeroleberis africana* from the Turonian of Tanzania, and notes that Apostolescu (1963) described two species (*S. gambiensis* and *S. senegalensis*) from the Senonian of west Africa.

Our specimens are fairly close to *S. africana* but differ in PM outline, which is less acuminate and more upturned. In this respect, they also differ from *Neocythere (Centrocythere) denticulata* Mertens, 1956, from the Upper Aptian to Upper Albian of western Europe.

Age and distribution

This species ranges Albian III to Albian VI in the Mzinene Formation of the Mkuze and Ndumu areas of northern Zululand.

Family **Schizocytheridae** Mandelstam, 1959

Genus *Sondagella* Dingle, 1969

This is a further taxon that is typical of the uppermost Jurassic to mid-Cretaceous of the western part of the South Gondwana ostracod province (Argentina, Agulhas Bank and Mozambique Ridge).

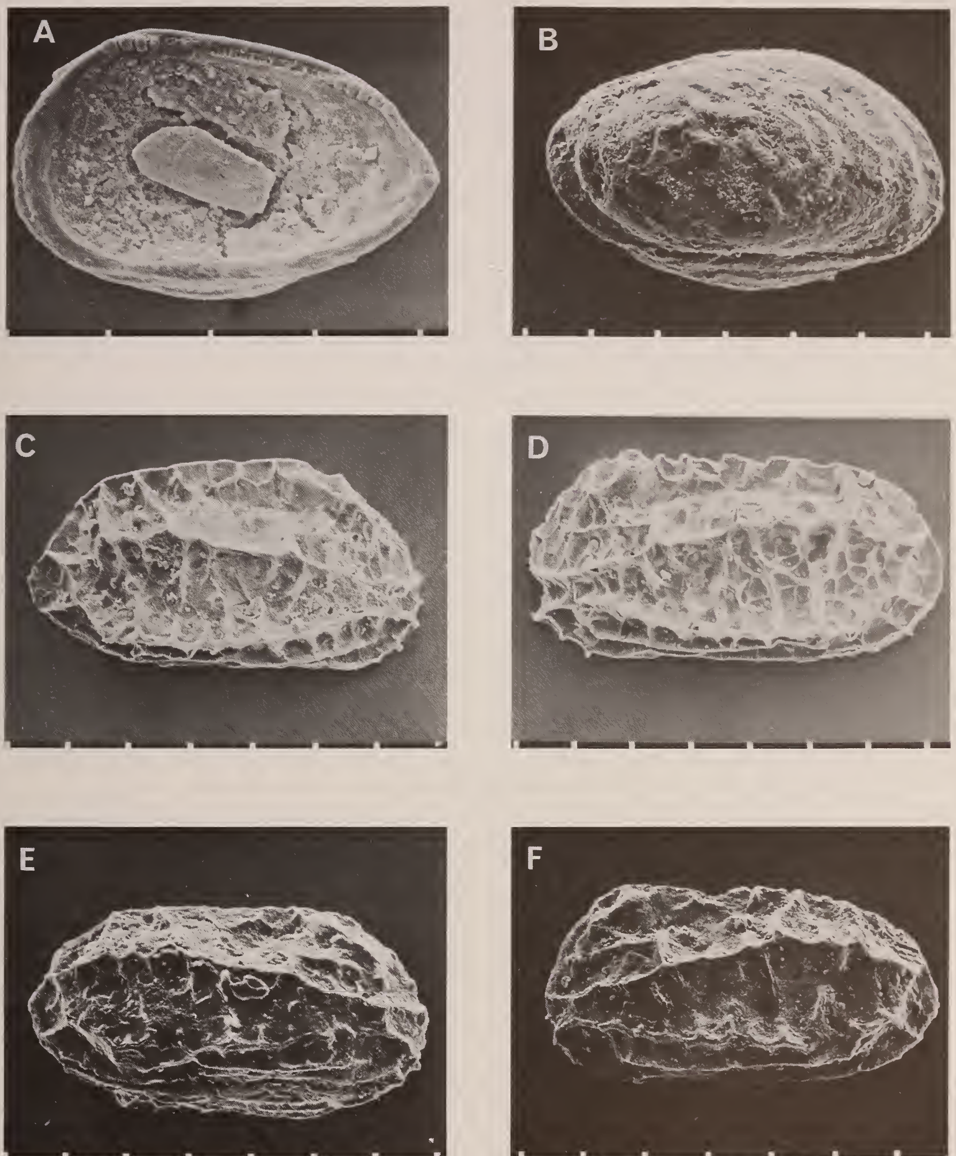


Fig. 26. A. *Collisarboris? stanleyensis*, SAM–PC6081, RV, DSDP 327, core 15–2/132–136 cm, late Albian. B. *Sphaeroleberis?* sp. A, SAM–PC6082, LV of carapace, locality 153, Mkuze, Zululand, Albian III. C–F. *Sondagella theloides* Dingle, 1969. C–D. TBD 1113, Agulhas Bank, Middle–Upper Albian. These two specimens are part of the population identified by Dingle (1971) as *Amphicytherura (Sondagella) theloides acuta*. C. SAM–PC6083, RV. D. SAM–PC6084, LV. E–F. Locality 153, Mkuze, Zululand, Albian III. E. SAM–PC6085, RV. F. SAM–PC6086, LV.
Scale bars = 100 μ.

Sondagella theloides Dingle, 1969

Fig. 26C–F

Amphicytherura (Sondagella) theloides Dingle, 1969: 157–161, fig. 13, pl. 9g–i. Brenner & Oertli, 1976: 496–497, pl. 4 (figs 13–16). McLachlan *et al.* 1976*b*: 363–364, fig. 15 (3–4). Musacchio, 1978: 464, pl. 1 (figs 21–23).
Amphicytherura (Sondagella) cf. *theloides* Dingle: Sigal, 1974: pl. 1 (fig. 6a–b).
Amphicytherura (S.) theloides acuta Dingle, 1971: 405–406, fig. 8.

Remarks

In view of the different lateral outline of *S. theloides* and *Amphicytherura dubia* Israelsky, 1929, Bate (1972) is followed here in raising *Sondagella* to generic status. The specimens of *S. theloides* from Zululand are very close to those from the southern Cape, but do seem to have a consistently less strongly curved anterior part to the longitudinal median rib, and a somewhat coarser aspect to ornamentation overall. The latter may, in part, be due to the relatively poor state of preservation of the Zululand material and, in any case, these variations are no more than can be expected intraspecifically from different geographical areas.

Musacchio (1978, 1979) records the species from Argentina, along with two closely related forms, *S. lestai* and an unnamed species that he placed in *?Acrocythere* sp. 2. He also recognized a variant of *S. theloides* that was described under *A. (S.) theloides* Form A (Musacchio 1978).

Age and distribution

S. theloides is known to have the following ranges and distribution:

1. Early Hauterivian in the Neuquen Basin of Argentina (Musacchio 1978).

2. Upper Valanginian to Lower Hauterivian, Lower Sundays River Formation, Algoa Basin (Dingle 1969; Brenner & Oertli 1976); Outeniqua Basin (McLachlan *et al.* 1976*b*).

3. ?Portlandian, Brenton Beds, Knysna (McLachlan *et al.* 1976*b*).

4. Middle–Upper Albian (TBD 1113), ?Alphard Formation, Outeniqua Basin, Agulhas Bank (Dingle 1971).

5. Albian III, Mzinene Formation, Mkuze area, Zululand.

6. Early Aptian or Barremian, DSDP site 249, Mozambique Ridge (core 26–1/40 cm) (Sigal 1974).

This suggests that *S. theloides* was widely distributed along the southern edge of West Gondwana in early to mid-Cretaceous time (Neuquen Basin in the west to Mozambique Ridge in the east), although it was absent from the eastern Falkland Plateau. Its temporal range in south-east Africa was ?Portlandian to Albian III (possibly Upper Albian in the Outeniqua Basin). It was probably an environmentally tolerant species that inhabited both shallow, near-shore (Algoa Basin), and deeper shelf areas (*c*. 200 m, Agulhas Bank) (see *Discussion*).

Family **Trachyleberididae** Sylvester-Bradley, 1948

Subfamily Trachyleberidinae Sylvester-Bradley, 1948

On the Falkland Plateau, trachyleberid ostracods are represented by one species (*Isocythereis sealensis*), which is relatively abundant at site 327 (average 8% in 6 samples, with a maximum of 14% in core 17). Generally speaking, however, these localities are noted for their relative lack of members of this family. In Zululand, in contrast, trachyleberid taxa are represented by 3 species in 2 genera which constitute an average of 36% of the total ostracod fauna in the 6 fossiliferous levels investigated (range 9–84%). To emphasize the contrast between the two areas further, the Falkland Plateau trachyleberids form an average of 31% of the cytheracean population, while in Zululand this figure is 51%.

Genus *Isocythereis* Triebel, 1940

Isocythereis sealensis Dingle, 1971

Figs 27A–F, 28A–D

Isocythereis sealensis Dingle, 1971: 412–413, fig. 14.

Neotype

SAM–PC6087, sample TBD 1113, ?Alphard Formation, Agulhas Bank, Middle–Upper Albian.

During the course of the present investigation, the holotype of the species (MG–3–1–6), which was a fragile specimen, fragmented. Sample 1113 originally contained five specimens. Following the destruction of the holotype, the paratype (MG–3–1–6) (Dingle 1971) has been retained as such, and one of the three remaining specimens has been selected as the neotype and illustrated.

Dimensions (mm)

	length	height
6087	0,61	0,35

Remarks

In the original description, Dingle (1971) identified small rounded eyespots. Re-examination of the type material under SEM shows this to be incorrect, and the species is now known to have been blind. Twenty additional specimens have been recovered from DSDP sites on the Falkland Plateau, and these allow a more broadly based assessment of the species' characters to be made.

External features that should be stressed are the flared margin over the anterior CA LV, and the prominent, narrow AM rim (both valves). Although the delicate reticulate ornamentation found in the Agulhas Bank specimens is met with in the Falkland Plateau material, the latter's ornamentation tends to be coarser, with the valves more heavily calcified.

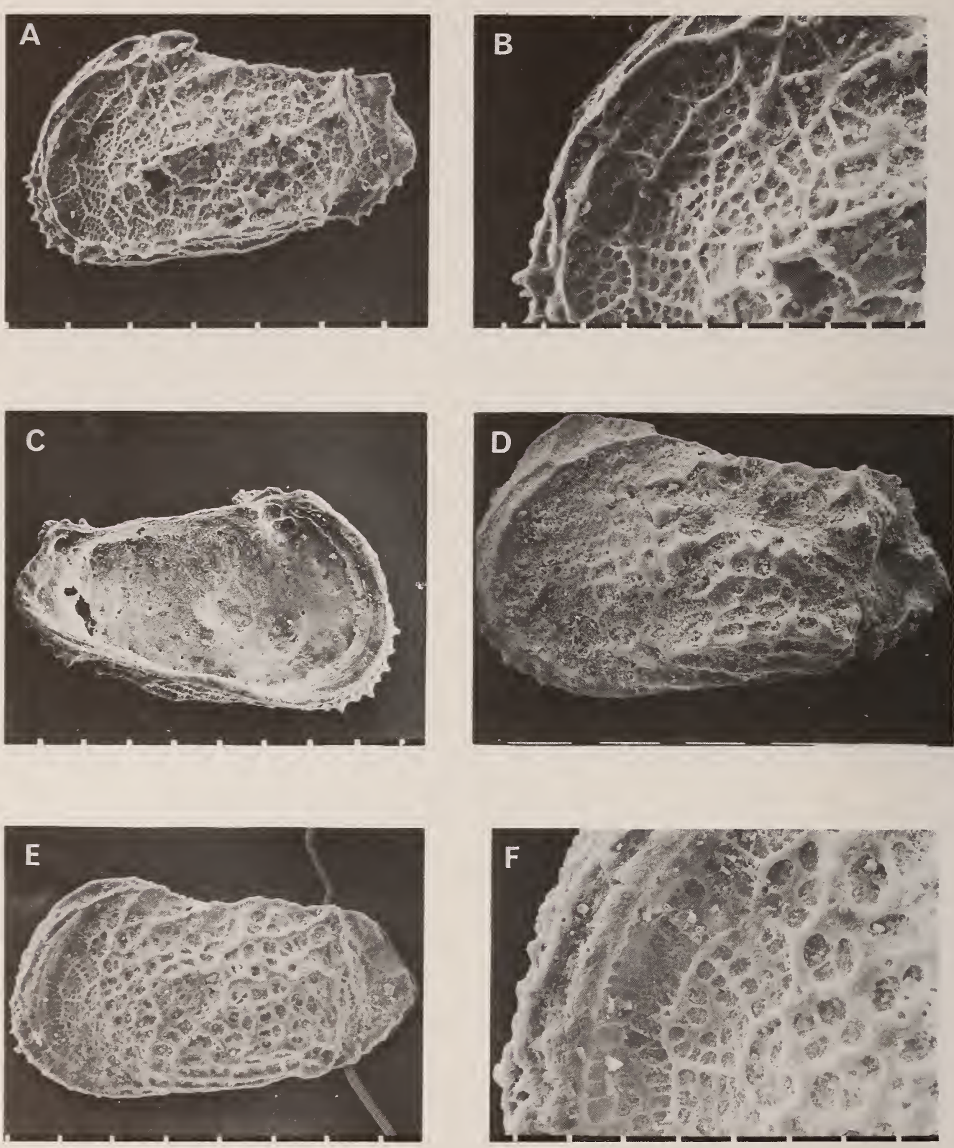


Fig. 27. A–F. *Isocythereis sealensis* Dingle, 1971. A–C. Neotype, SAM–PC6087, LV, TBD 1113, Agulhas Bank, Middle–Upper Albian. A. External lateral view. B. Detail anterior area. C. Internal view. D–F. DSDP 327. D. SAM–PC6088, LV, core 16–6/125–130 cm, middle Albian. E–F. SAM–PC6089, LV, core 15–2/132–136 cm, late Albian. E. External lateral view. F. Detail anterior area.
Scale bars: A, C–E = 100 μ, B, F = 30 μ.

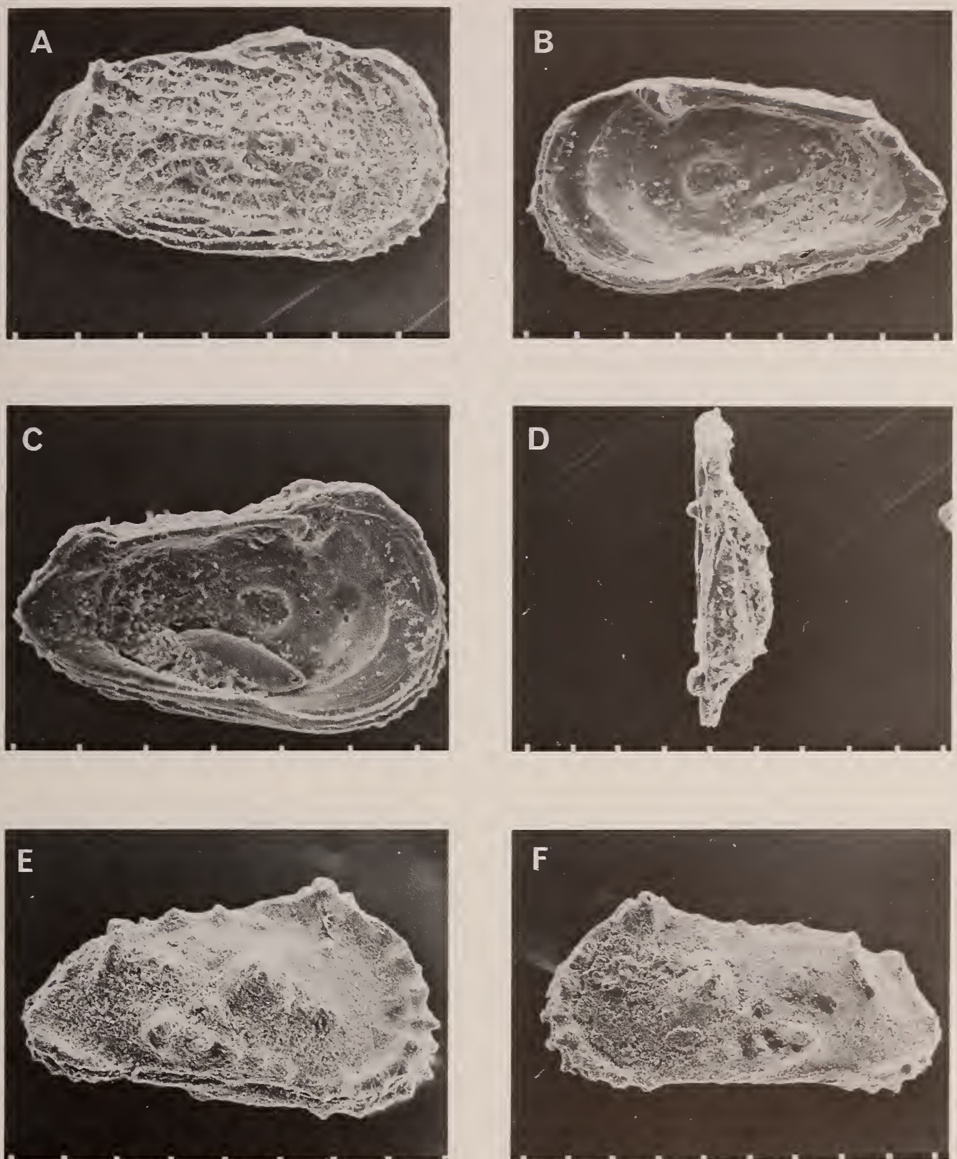


Fig. 28. A–D. *Isocythereis sealensis* Dingle, 1971. A. SAM–PC6090, RV, DSDP 330, core 1–1/112–110 cm, early–middle Albian. B. SAM–PC6092, RV, DSDP 327, core 16–6/125–130 cm, middle Albian. C. SAM–PC6093, LV, DSDP 327, core 15–2/132–136 cm, late Albian. D. SAM–PC6091, RV dorsal view, DSDP 327, core 18–6/106–110 cm, middle Albian. E–F. *Isocythereis? ndumuensis* sp. nov., locality Ndumu 3–1, Inyamathi Pan, Zululand, Cenomanian III. E. Holotype, SAM–PC6094, RV. F. SAM–PC6095, LV. Scale bars = 100 μ.

Internally, it can now be established that while the hinge is hemiamphidont, the ATE RV is weakly subdivided and the PTE LV consists of a large socket that opens broadly into the valve interior and has a thick, humped exterior rim. ATE LV is also a rather broad structure, opening into the interior of the valve.

Bate (in Bate & Bayliss 1969) recorded *Isocythereis* sp. (British Museum Io 782) from the Turonian of Tanzania, but this species differs from *I. sealensis* in having large eye-spots, a prominent SCT, a thick AM rim, and bluntly spinose ornamentation on the dorso- and ventrolateral longitudinal ribs.

Age and distribution

In South Africa, *I. sealensis* is known only from sample TBD 1113 on the Agulhas Bank (Middle–Upper Albian). On the Falkland Plateau it ranges as follows: DSDP 330 early–middle Albian (core 1–1/112–116 cm); DSDP 327 middle to late Albian (cores 18–6/106–116 cm to 15–2/132–136 cm). It is never abundant, but at two levels (DSDP 327 core 17 and core 15) reaches 14% and 10% respectively, of the total ostracod population.

Isocythereis? ndumuensis sp. nov.

Figs 28E–F, 29A

Derivation of name

Locality of type specimens, Ndumu region of northern Zululand.

Holotype

SAM–PC6094, C, locality Ndumu 3–1, Inyamathi Pan, Mzinene Formation, Cenomanian III.

Paratypes

SAM–PC6095, C, as above.

SAM–PC6096, C, as above.

SAM–PC6097, C, locality 178, Msunduzi Pan, Ndumu, Mzinene Formation, Albian VI.

Diagnosis

Species with elongate triangular lateral outline, smooth to weakly reticulate intercostal areas, prominent turret-like eye-spot.

Description

External features. In lateral view elongate, asymmetrically rounded AM with short stout spines anteroventrally, DM and VM converge posteriorly, both are weakly concave. PM is triangular. Anterior and posterior CA prominent, with turret-like eye-spots in both RV and LV. Posteroventral margin weakly spinose. Surface ornamented with dorsal and ventral spinose ridges and lines of spines. The ventral ridge typically consists of 5 stout spines on a low elevation that rises posteriorly and is continuous with the well-developed spinose AM ridge. The dorsal lineation consists of four low spines on a weak ridge, and culminates posteriorly in a well-developed CA and a short low ridge that runs parallel to the posterior margin in LV, and almost at right angles to DM in RV. There is a prominent rounded SCT bearing stout spines. In RV there is also a small spine anteroadjacent to the SCT. Intercostal areas typically smooth, but Albian specimens have weak intercostal reticulation.

Internal features. None seen.

Remarks

Tentatively placed in *Isocythereis* on general external features. The new species is very similar to *Isocythereis* sp. (British Museum Io 782) from the Turonian of Tanzania (Bate & Bayliss 1969) but is overall less spinose. It differs from *I. sealensis* from the Agulhas Bank and the Falkland Plateau by possessing large eye-spots (*I. sealensis* is blind), and by lacking well-developed reticulate ornamentation. *Spinoleberis?* GA E 12 (Grosdidier 1979) from the Upper Cenomanian of Gabon has a similar ornamentation to *I? ndumuensis*, but is more elongate and apparently lacks a prominent eye-spot.

Dimensions (mm)

	length	height	width
6094	0,75	0,40	
6095	0,84	0,42	
6096	0,90		0,45
6097	0,84	0,38	

Age and distribution

I? ndumuensis is known to range Albian VI to Cenomanian III in the Ndumu region of Zululand.

Genus *Cythereis* Jones, 1849

Cythereis agulhasensis Dingle, 1971

Fig. 29B–D

Cythereis agulhasensis Dingle, 1971: 411–412, fig. 13.

Remarks

No further specimens of this distinctive species have been recovered, but SEM pictures are included here to amplify the original description. In particular, attention is drawn to the delicate recticulate and foveolate ornamentation at the posterior ends of the median and ventrolateral ridges, which contrasts with the otherwise overall smooth valve surface. The MS pattern is now shown to consist of four elongate adductors and a U-shaped anterior scar.

The holotype originally designated MG–5–1–2 by Dingle (1971) has now been placed in the South African Museum under catalogue number SAM–PC6098.

Age and distribution

Known only from sample TBD 1266, ?Alphard Formation on the Agulhas Bank (Upper Aptian–Albian).

Genus ***Makatinella*** gen. nov.

Derivation of name

Locality of holotype, Makatini Flats, Zululand.

Type species

Makatinella tritumida sp. nov.

Diagnosis

Trachyleberid with the following characters: asymmetrically rounded AM, large anterior hinge ears in LV and RV, prominent eye-spots, straight VM forming continuation with the ventrally deflected PM, prominent rounded SCT, three longitudinal ribs, fourteen to sixteen anterior RPC. Surface weakly reticulate to smooth with numerous pustules.

Remarks

Makatinella has some similarities with *Cornicythereis* Gründel, 1973 (which Damotte (1977) considers a subgenus of *Cythereis*) and *Costacythere* Gründel 1966, but differs from both in possessing a straight VM that is contiguous with the PM. *Rehacythereis* Gründel, 1973 (which Damotte (1977) also considers a subgenus of *Cythereis*) differs from *Makatinella* in lacking the prominent anterior hinge ears and well-defined median rib. Despite these differences, *Makatinella* is clearly related to these European *Cythereis*-like taxa, which have the following ranges: *Cornicythereis*—?Barremian to Albian (Gründel 1974); *Costacythereis*—Hauterivian to Barremian (Bartenstein & Oertli 1975); and *Rehacythereis*—?Valanginian to Palaeocene (Gründel 1974).

Cythereis itself has a centrally pointed PM and a symmetrically rounded AM.

Age and distribution

The two new species recognized in this study, *M. tritumida* and *M. inflata*, range Aptian IV to Cenomanian III and Aptian IV to Albian III respectively, and are known only from Zululand.

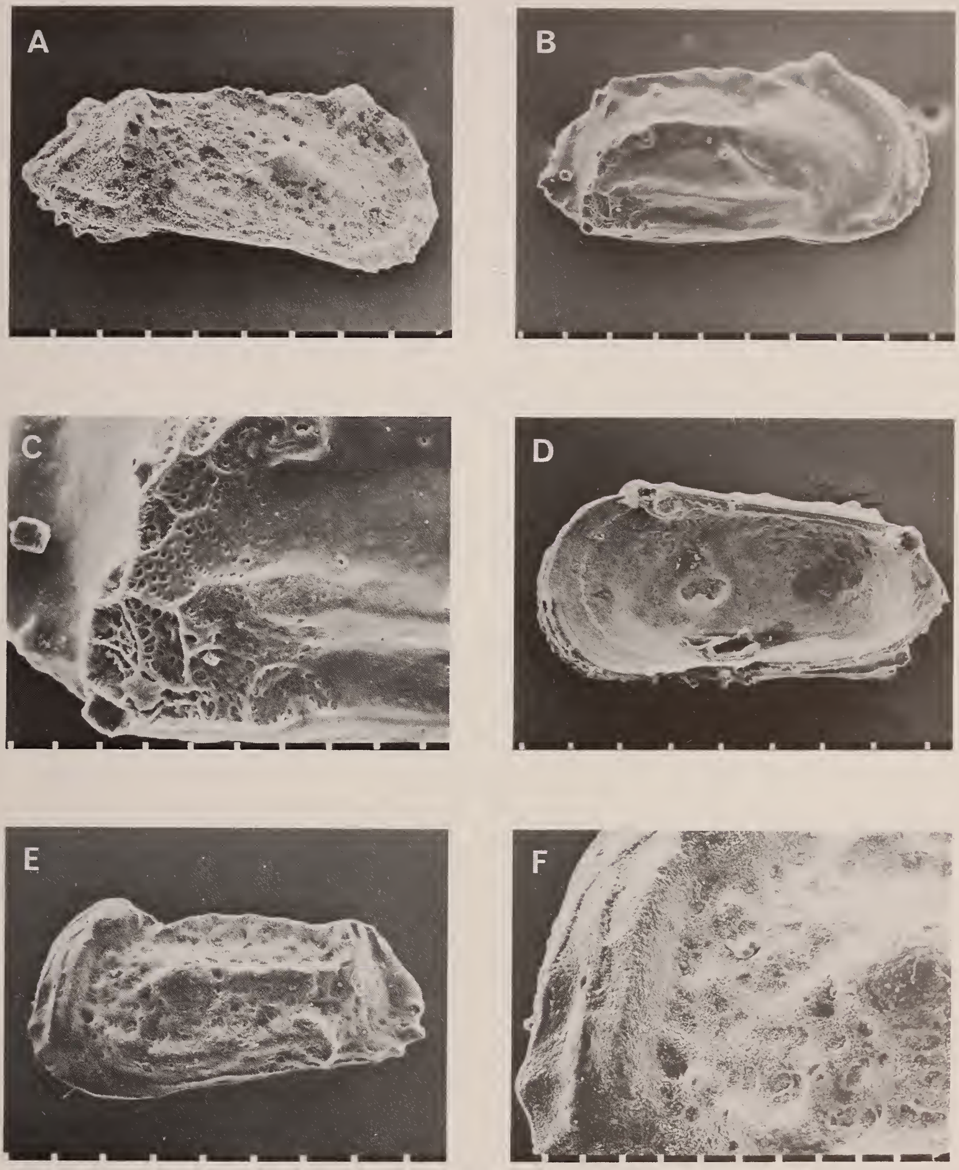


Fig. 29. A. *Isocythereis? ndumuensis* sp. nov., SAM–PC6097, RV, locality 178, Ndumu, Zululand, Albian VI. B–D. *Cythereis agulhasensis* Dingle, 1971, holotype, SAM–PC6098, RV, TBD 1266, Agulhas Bank, Upper Aptian–Albian. B. External lateral view. C. Detail postero-ventral area. D. Interior view. E–F. *Makatinella tritumida* gen. et sp. nov., holotype, SAM–PC6099, RV, locality 171–1, Mlambongwenya Spruit, Zululand, Aptian IV. E. External lateral view. F. Detail anterior area.
Scale bars: A–B, D–E = 100 μ, C, F = 30 μ.

Makatinella tritumida sp. nov.

Figs 29E–F, 30A–D

Derivation of name

Latin *tres tumor*: reference to three pustules postadjacent to AM rim.

Holotype

SAM–PC6099, LV, locality 171–1, Makatini Formation, Mlambongwenya Spruit, Aptian IV.

Paratypes

SAM–PC6101, C, as above.

SAM–PC6100, C, locality 171–21, Makatini Formation, Mlambongwenya Spruit, Albian III.

Diagnosis

Species with prominent AM rim and three pustules postadjacent to it.

Description

External features. Carapace elongate rectangular, AM broadly and asymmetrically rounded, DM and VM straight with no posterior convergence, PM asymmetrically pointed so that posteroventral part forms continuation of VM. Posteroventral and anteroventral margins bear short stout spines. Anterior hinge ears prominent, rounded, and forming highest points of the valves. In dorsal view, posterior area compressed, widest part of valve in posterior one third. Eye-spots large, set below hinge ears. Lateral surface bears three prominent ridges: dorsal ridge is sharp and straight or slightly convex dorsally, starting behind anterior hinge ear and running to a prominent posterodorsal corner where a short transverse ridge abuts at a right angle; median ridge is narrow and sharp, running from a prominent rounded SCT to the aforementioned transverse ridge; ventral ridge has upturned anterior end and terminates posteriorly in a ventrally projecting spur. There is a prominent AM ridge that runs from the eye-spot to about three-quarters down the AM where it abruptly terminates. Surface ornamentation ranges from smooth with a few scattered pustules, to coarsely but indistinctly recticulate. All varieties bear three hollow pustules postadjacent to the AM ridge.

Interior features. Not well seen, but hinge amphidont with large arches over the TE in LV. Elements apparently smooth, but all specimens were badly worn. MS in central pit, apparently V-shaped anterior scar and four adductors. MA narrow, *c*. 15–16 RPC in anterior RV.

Remarks

In many aspects of general shape and ornamentation *M. tritumida* resembles *Sergipella transatlantica* Krömmelbein, 1967, as illustrated by Grosdidier

(1979) from the late Aptian to early Albian of Gabon, and recorded from the Albian Riachuelo Formation of eastern Brazil by Krömmelbein (1967, 1972). The two species differ in the shape of their posteroventral regions, with *S. transatlantica* having a sharp upswing to a centrally pointed PM outline.

Dimensions (mm)

	length	height
6099	0,80	0,40
6100	0,90	0,46
6101	0,73	0,38

Age and distribution

This species is known to range Aptian IV to Cenomanian III in the Mlambongwenya Spruit (Aptian IV to Albian III) and Ndumu (Cenomanian II to III) regions of Zululand.

Makatinella inflata sp. nov.

Figs 30E–F, 31A–C

Derivation of name

Latin *inflata*: reference to plump, inflated nature of carapace.

Holotype

SAM–PC6102, C, locality 153, Mzinene Formation, Mantuma Rest Camp, Mkuze area, Albian III.

Paratypes

SAM–PC6103, C, as above.
SAM–PC6104, LV, as above.
SAM–PC6105, RV, as above.
SAM–PC6106, C, as above.

Diagnosis

Species with inflated aspect, subdued surface ornamentation, distinct downturned posteroventral margin.

Description

External features. Subquadrate lateral outline, AM broadly and asymmetrically rounded. DM and VM straight with little or no convergence posteriorly. PM asymmetric, ventrally deflected with short stubby spines. Anterior hinge ear prominent, no AM rim. There are three longitudinal ridges: dorsal ridge is slightly dorsally convex, has a downturned anterior end, and terminates at a sharp right angle corner; median ridge starts at a large but indistinct SCT and terminates directly below the termination of the dorsal ridge; and ventral ridge is low and indistinct and is upturned at its posterior end. Valve surface smooth except for indistinct nodes and pustules. In dorsal view carapace is arrowhead-shaped.

Internal features. Not well preserved. MA moderate to narrow, 14–15 RPC anteriorly. Hinge amphidont, all elements apparently smooth, but no unworn specimens available. PTE in LV lies in an arched recess.

Remarks

M. inflata differs from the type species in lacking an AM ridge, in being more inflated overall, in having less well-defined longitudinal ridges, and having a less angular outline in dorsal view with maximum width over SCT, compared to maximum width over the median ridge in the posterior third in *M. tritumida*.

Dimensions (mm)

	length	height	width
6102	0,72	0,40	
6103	0,69	0,34	
6104	0,72	0,35	
6105	0,74	0,36	
6106	0,72		0,37

Age and distribution

This species is known to range Aptian IV to Albian III in the Mkuze and Mlambongwenya Spruit areas of northern Zululand.

Family **Schulerideidae** Mandelstam, 1959

Genus *Pirileberis* Grekoff, 1963

Pirileberis makatiniensis sp. nov.

Figs 31D–F, 32, 33A

Derivation of name

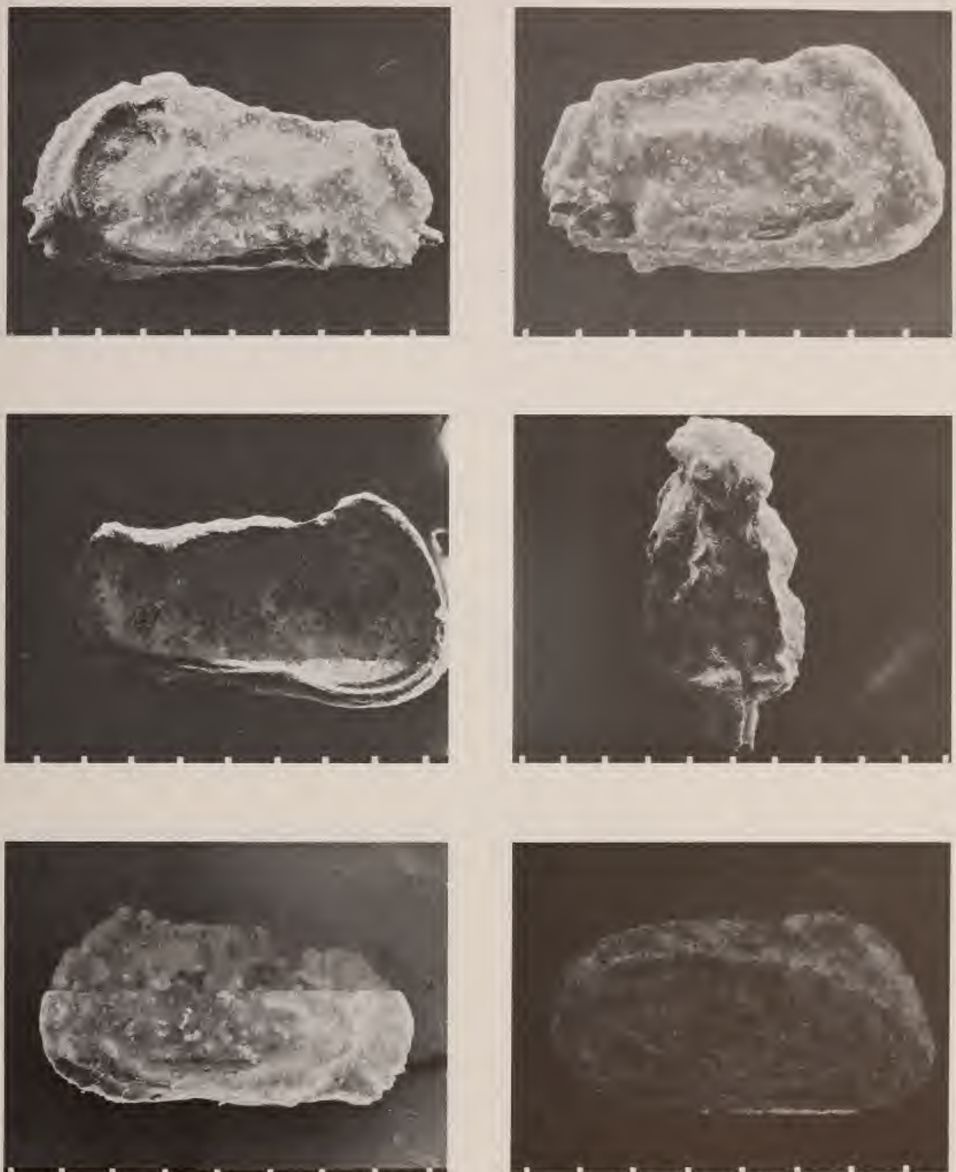
Locality of type specimens on the Makatini Flats, northern Zululand.

Holotype

SAM–PC6107, LV, locality 171–21, Mlambongwenya Spruit, Mzinene Formation, Albian III.

Paratypes

SAM–PC6108, C, as above.
SAM–PC6109, RV, as above.
SAM–PC6110, RV, as above.



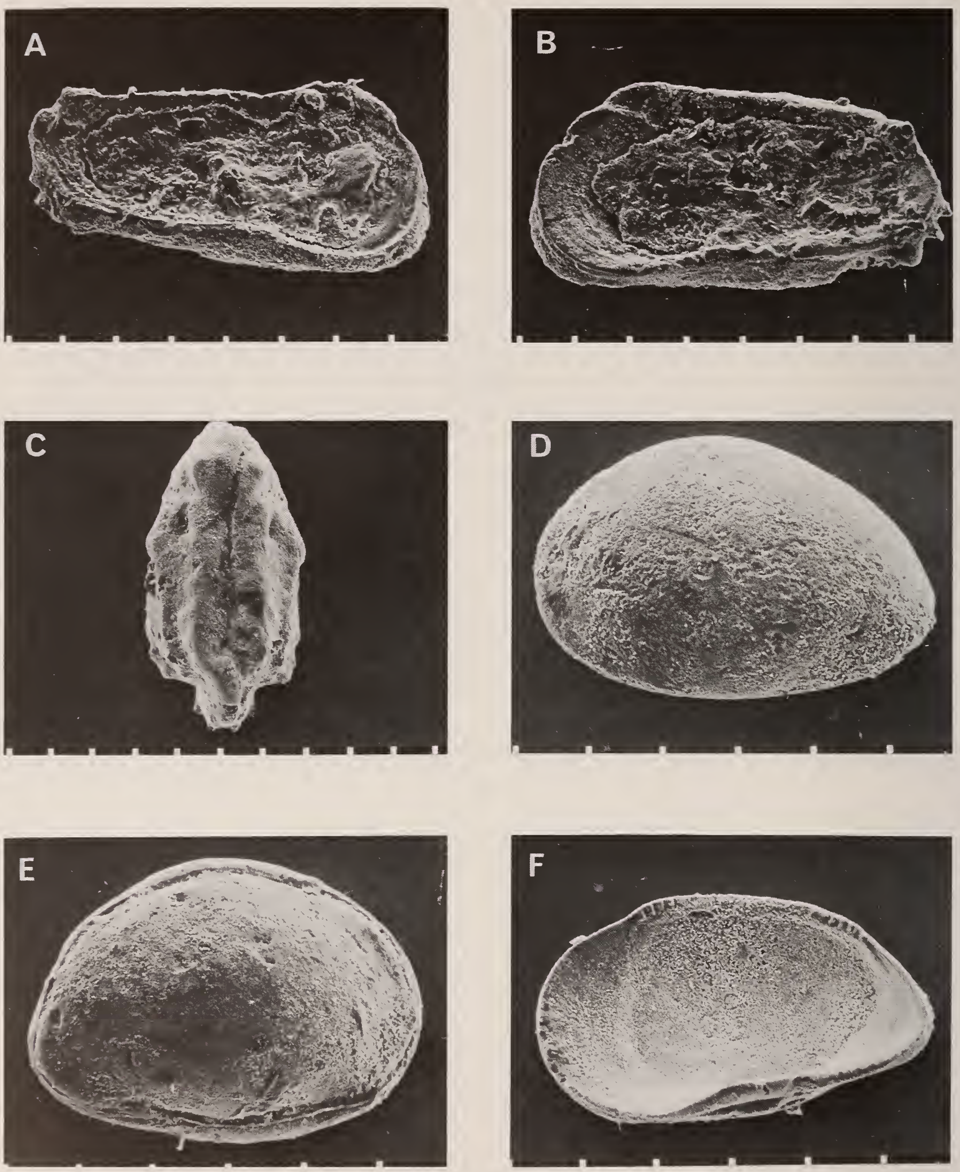


Fig. 31. A–C. *Makatinella inflata* gen. et sp. nov., locality 153, Mkuze, Zululand, Albian III. A. SAM–PC6104, LV internal view. B. SAM–PC6015, RV internal view. C. SAM–PC6106, C, dorsal view. D–F. *Pirileberis makatiniensis* sp. nov., locality 171–21, Mlambongwenya Spruit, Zululand, Albian III. D. Holotype, SAM–PC6107, LV. E. SAM–PC6108, RV. F. SAM–PC6109, RV internal view.
Scale bars = 100 μ.

Diagnosis

Species with curved DM, weakly convex VM, and slightly ventrally deflected PM apex.

Description

External features. Plump ovate aspect in lateral view. AM broadly rounded, DM convex, VM weakly convex, PM acutely rounded with apex directly slightly ventrally. Highest point of valve at mid-length. Valve surface smooth.

Internal features. MA moderately wide, with numerous (*c*. 15) fine RPC anteriorly. Hinge merodont, gently curved: in RV ATE has five teeth, PTE has six teeth, ME is a crenulate groove; in LV TE are sockets with ventral ledges, ME is a curved denticulate bar and a narrow, overhung accommodation groove. MS consist of a curved row of four rounded adductors and a large rounded anterior scar (Fig. 32).

Fig. 32. Muscle scars of *Pirileberis makatiniensis* sp. nov., SAM–PC6109, RV, locality 171–21, Mlambongwenya Spruit, Albian III.
Scale bar = 30 μ.

Remarks

P. makatiniensis differs from the type species (*P. progonata* Grekoff, Kimmeridgian to Valanginian of Madagascar) in having a straighter VM in lateral view, its line of greatest length well below mid-height, and in its MS pattern, which has the anterior scar in a more ventral position. *P. makatiniensis* differs from *P. mkuzensis* sp. nov. in details of lateral outline, hinge structure, and MA.

Dimensions (mm)

	length	height
6107	0,53	0,35
6108	0,52	0,37
6109	0,53	0,30
6110	0,53	0,35

Age and distribution

P. makatiniensis is known to range Aptian IV to Albian III (Makatini and Mzinene formations) in the Mkuze (locality 150) and Mlambongwenya Spruit (locality 171) areas of Zululand.

Pirileberis mkuzensis sp. nov.

Fig. 33B–E

Derivation of name

Locality of type specimens in the Mkuze area, northern Zululand.

Holotype

SAM–PC6111, RV, locality 153, Mantuma rest camp, Mkuze Game Park, Mzinene Formation, Albian III.

Paratypes

SAM–PC6112, LV, as above.
SAM–PC6113, C, as above.
SAM–PC6114, LV, as above.

Diagnosis

Species with subtriangular outline of LV in lateral view.

Description

External features. Asymmetrically rounded AM. DM and VM converge toward small, bluntly rounded PM. DM is straight, VM gently convex. Highest point of valve immediately anterior of mid-length. In LV lateral outline is subtriangular. Valve surface smooth.

Internal features. MA narrow, with about nine fine, indistinct anterior RPC that are grouped in the lower half of margin along axis of greatest length. Hinge merodont. In RV, ATE and PTE strong, of equal size, with six teeth; ATE inclined at angle to main hinge line. ME is a straight denticulate groove above which lies a narrow bar. In LV structures are complementary, including a narrow accommodation groove. MS not seen.

Remarks

P. mkuzensis differs from the type species (*P. progonata* Grekoff) in possessing a straighter VM, particularly in LV, and fewer RPC (9 cf. 20–24). It can be distinguished from *P. makatiniensis* sp. nov. on details of lateral outline, hingement, and number of RPC.

Fig. 33. A. *Pirileberis makatiniensis* sp. nov., SAM–PC6110, LV, interior view, locality 171–21, Mlambongwenya Spruit, Zululand, Albian III. B–E. *Pirileberis mkuzensis* sp. nov., locality 153, Mkuze, Zululand, Albian III. B. SAM–PC6112, LV. C. SAM–PC6113, RV. D. SAM–PC6114, LV internal view. E. Holotype, SAM–PC6111, RV, internal view. F. *Asciocythere? dubia* sp. nov., SAM–PC6116, LV, DSDP 330, core 1/cc, early–middle Albian.

Scale bars = 100 μ.

Dimensions (mm)

	length	height
6111	0,64	0,34
6112	0,67	0,41
6113	0,69	0,40
6114	0,65	0,35

Age and distribution

P. mkuzensis is known to range Aptian IV to Albian III (Mkatini and Mzinene formations), in the Mkuze area of Zululand (localities 150 and 153).

Genus *Asciocythere* Swain, 1952

Asciocythere? dubia sp. nov.

Figs 33F, 34A–B

Derivation of name

Latin *dubia*, uncertain: reference to uncertain taxonomic status.

Holotype

SAM–PC6115, RV, DSDP 330, core 1/cc, early–middle Albian.

Paratypes

SAM–PC6116, LV, as above.
SAM–PC6117, LV, as above.

Diagnosis

Smooth species with elliptical LV, more elongate RV, hinge modified hemimerodont.

Description

External features. LV larger than RV. LV elliptical with round AM and narrow rounded PM, DM and VM strongly convex, outline tapering posteriorly. Highest point of valve in front of mid-length, maximum length at about mid-height. RV more elongate than LV, with straight VM, convex DM. Surface entirely smooth. No eye-spots.

Internal features. Narrow MA. MS not seen. Hinge modified hemimerodont: in RV small elongate weakly crenulate TE project dorsally, ME is a smooth, straight bar with a narrow accommodation groove; in LV TE are narrow sockets under the DM with an ME depression and DM overhang.

Remarks

This species is tentatively placed in the genus *Asciocythere* on the grounds of general shape and hinge, although in detail it is not very close to any species so far assigned to the genus. The type species *A. rotunda* (Vanderpool 1928) has a similar lateral outline to *A? dubia* but is less elliptical and has a conventional hemimerodont hinge.

Asciocythere is a typical Upper Jurassic to mid-Cretaceous taxon from North America (see Swain 1972; Neale 1977), and Swain (1976) has recorded an *Asciocythere* sp. from DSDP site 137 (core 11–1/86–92 cm) off north-western Africa in ?Cenomanian strata. The latter is a punctate species with a weakly convex VM. Damotte (1979) records *Asciocythere* sp. 68 from the Aptian of DSDP 400A (core 68–1/72–73 cm) in the north-western Bay of Biscay, but her specimen has a more strongly arched LV DM and lacks the upswept posteroventral outline of *A? dubia*.

Dimensions (mm)

	length	height
6115	0,51	0,26
6116	0,41	0,22
6117	0,41	0,23

Age and distribution

A? dubia is known only from the early–middle Albian at DSDP site 330 (core 1/cc), where it is rare (*c*. 3%).

Family uncertain

Aitkenicythere Bate, 1976

Aitkenicythere? striosulcata sp. nov.

Fig. 34C–F

Derivation of name

Latin *striatus* (striation) + *sulcus* (sulcus): reference to striate ornamentation and prominent dorsomedian sulcus.

Holotype

SAM–PC6119, RV, DSDP 327, core 21–3/71–76 cm, early Albian.

Paratypes

SAM–PC6118, LV, DSDP 327, core 21–3/71–76 cm, early Albian.
SAM–PC6120, RV, DSDP 330, core 1/cc, early–middle Albian.

Diagnosis

Species with fine longitudinal ribs and a prominent dorsomedian sulcus.

Description

External features. Elongate subquadrate in lateral view. AM broadly and symmetrically rounded, typically with a border frill, PM RV asymmetrically acuminate with maximum length below mid-height, PM LV truncated with weak posteroventral extension. DM straight, but with small prominent concavity about mid-length, VM straight in LV, slightly concave in RV. DM and VM converge posteriorly. Surface ornamented with fine, broken, longitudinal ribs and weak intercostal muri that produces reticulation. There is a dominant median rib that runs from near the AM across the mid-point of the valve, posterior of which it rises and has a dorsally convex hook. There are numerous wide, well-spaced pustulate normal pore openings on the lateral surface. In the dorsal and median part of the valve there is a low sulcus across which median ribs are deflected and converge. A further prominent rib runs obliquely across the anterior CA.

Internal features. MA wide, apparently no vestibules and few (?five) anterior RPC. Hinge lophodont with long straight ME bar in LV with two deep rounded TE sockets that are partly enclosed by the duplicature. Posteroventral MA of RV is apparently wider than corresponding structure in LV. NPC openings are prominent.

Remarks

Position within genus is provisional. *A? striosulcata* compares favourably with the type species *A. gracilis* (Bate, 1975), but is not so slim in dorsal view, and has a slightly different ornamentation.

Dimensions (mm)

	length	height
6110	0,42	0,22
6119	0,42	0,22
6120	0,33	0,17

Age and distribution

A? striosulcata ranges early–middle Albian at DSDP site 330 (core 1–1/cc to 112–116 cm) and early Albian at DSDP site 327 (core 21–3/71–76 cm), where it is rare (3–5 % at 330) to abundant (31 % at 327).

Aitkenicythere? sp. 327/18

Fig. 35A

Acrocythere? sp. A Oertli, 1974: 949, pl. 7 (fig. 6).

Remarks

One carapace of a small cytheracean with three prominent blade-like longitudinal ridges, the dorsal of which is continuous with the AM ridge. Although no internal views are available, this specimen appears close to *Aitkenicythere gracilis* (Bate, 1975), and it possibly belongs to the same species as a specimen identified as *Acrocythere?* sp. A by Oertli from DSDP site 261 off north-western Australia.

The specimen differs from the type species of *Aitkenicythere* by being less laterally compressed and by possessing an AM ridge.

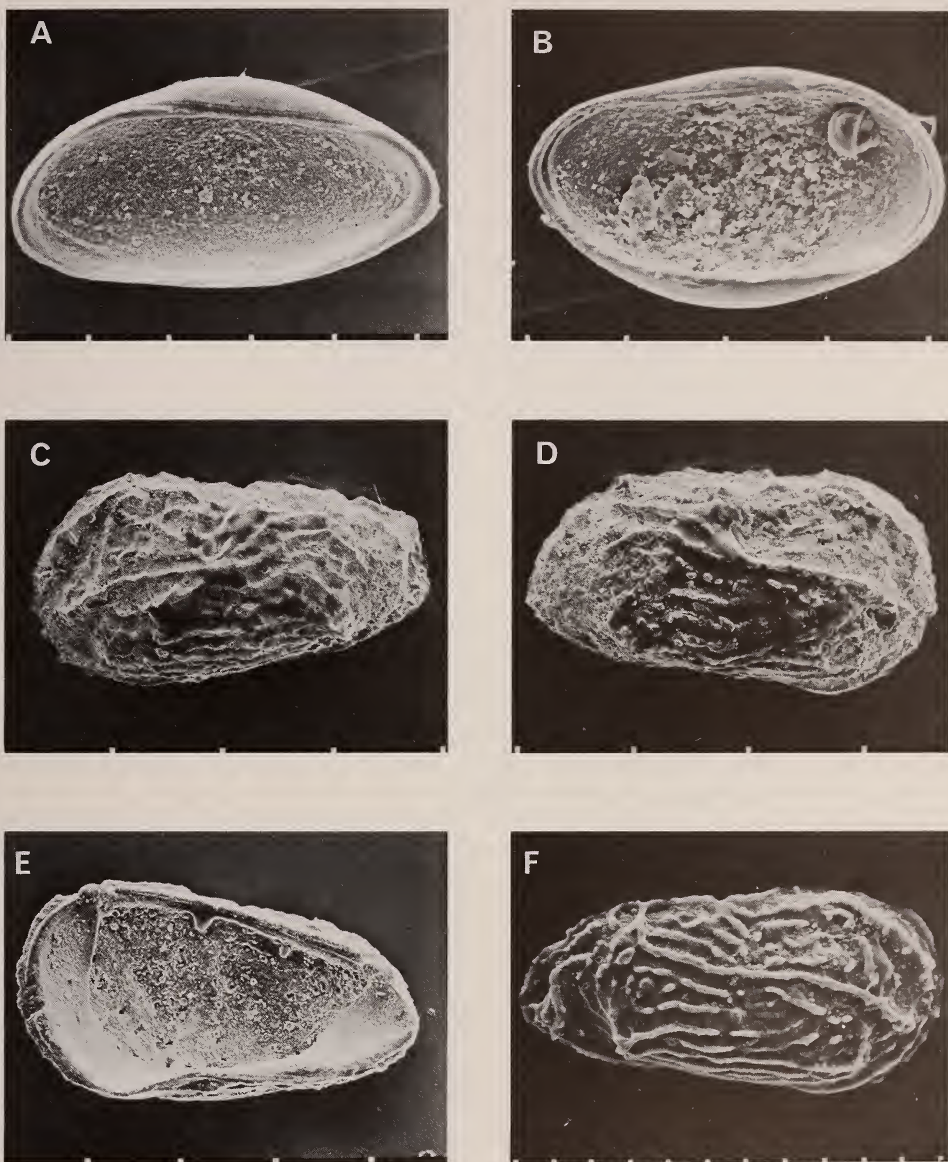


Fig. 34. A–B. *Asciocythere? dubia* sp. nov., DSDP 330, core 1/cc, early–middle Albian. A. Holotype, SAM–PC6115, RV internal view. B. SAM–PC6117, LV internal view. C–F. *Aitkenicythere? striosulcata* sp. nov. C–D. DSDP 327, core 21–3/71–76 cm, early Albian. C. Holotype, SAM–PC6119, LV. D. SAM–PC6118, RV. E–F. SAM–PC6120, RV, DSDP 330, core 1/cc, early–middle Albian. E. Internal view. F. External lateral view. Scale bars: A–E = 100 μ, F = 30 μ.

Dimensions (mm)

	length	height
6121	0,37	0,18
Holotype of *Aitkenicythere gracilis* (Bate, 1975)	0,41	0,21
Acrocythere? sp. A Oertli 1974	0,41	0,21

Age and distribution

Aitkenicythere? sp. 327/18 occurs at one level in the middle Albian of DSDP 327 (core 18–2/51–55 cm) on the Falkland Plateau.

Acrocythere? sp. A Oertli occurs in an Upper Oxfordian horizon in DSDP 261 (core 33–1/0–20 cm) off north-western Australia.

Aitkenicythere gracilis (Bate, 1975) (type species) occurs in the Middle or Upper Kimmeridgian (samples B219 & B223) of the Mandawa anticline, Tanzania.

Indet. sp. 1

Fig. 35B

Remarks

One carapace of a distinctly shaped and ornamented species. Overall the carapace is plump, with a sharply upswinging posteroventral margin. PM apex is above mid-height. The ornamentation consists of narrow vertical ridges arranged concentrically about the mid-length.

Bertels (1969) has described a species with similar ornamentation and shape from the Lower Maastrichtian of Argentina *(Semicytherura? similis).*

Age and distribution

Aptian III, Makatini Formation, locality 150–11, northern side of Nhlohlela Pan, Mkuze area, northern Zululand.

Indet. sp. 2

Fig. 35C

Remarks

One poorly preserved carapace showing faint longitudinal lineations along the ventromedian surface. Shape and ornamentation reminiscent of *Progonocythere reticulata* Dingle (in Dingle & Klinger 1972) from the ?Portlandian to Valanginian of the southern Cape coast (see McLachlan *et al.* 1976*b*).

Age and distribution

Aptian IV, Makatini Formation, locality 150–21, northern side of Nhlohlela Pan, Mkuze area, northern Zululand.

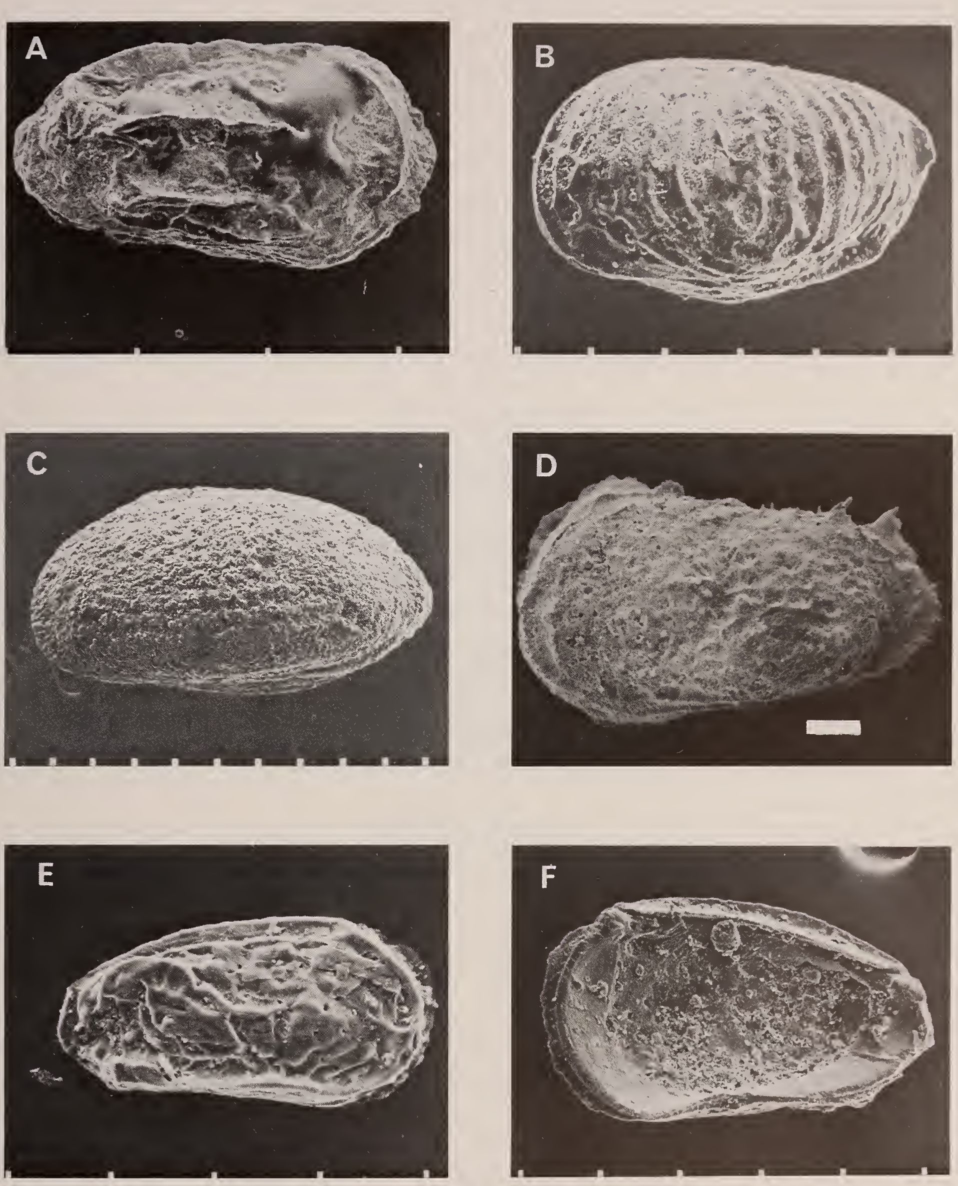


Fig. 35. A. *Aitkenicythere?* sp. 327/18, SAM–PC6121, RV, DSDP 327, core 18–2/51–55 cm, middle Albian. B. Indet. sp. 1, SAM–PC6122, LC, locality 150–11, Mkuze, Zululand, Aptian III. C. Indet. sp. 2, SAM–PC6123, LV, locality 150–21, Mkuze, Zululand, Aptian IV. D. Indet. sp. 327/16A, LV, DSDP 327, core 16–4/66–70 cm, middle Albian. E–F. Indet. sp. 330/1, SAM–PC6124, RV, DSDP 330, core 1/cc, early–middle Albian. E. External lateral view. F. Internal view.
Scale bars = 100 μ.

Indet. sp. 330/1

Fig. 35E–F

Remarks

Two valves of a small, heavily ornamented species with an overall leptocytherid appearance. It has wide MA and a lophodont hinge, a prominent ridge along the DM, and a rib that is continuous round the AM and VM. NPC are conspicuous.

Age and distribution

Occurs in the early-middle Albian of DSDP 330 (core 1/cc).

Indet. sp. 327/16A

Fig. 35D

Remarks

Single valve, probably juvenile of a blind trachyleberid-like species. Salient features include small median sulcus, inflated posteroventral area, small, flat spine on dorsal part of posterior margin, reticulate, hirsute ornamentation, lophodont hinge. MS consist of V-shaped anterior scar and vertical row of four posterior scars.

Age and distribution

Occurs in the middle Albian of DSDP 327 (core 16–4/66–70 cm).

Indet. sp. 327/16B

Fig. 36A–B

Remarks

Shape reminiscent of neocytherid taxa with reticulate ornamentation. The hinge is lophodont with long narrow TE.

Age and distribution

Occurs in the middle Albian of DSDP site 327 (core 16–4/66–70 cm).

Indet. sp. 327/18

Fig. 36C

Remarks

Small species with a strongly arched DM, straight VM, acuminate PM, and rounded AM. No internal views seen.

Age and distribution

Occurs in the middle Albian of DSDP site 327 (core 18–2/51–55 cm).

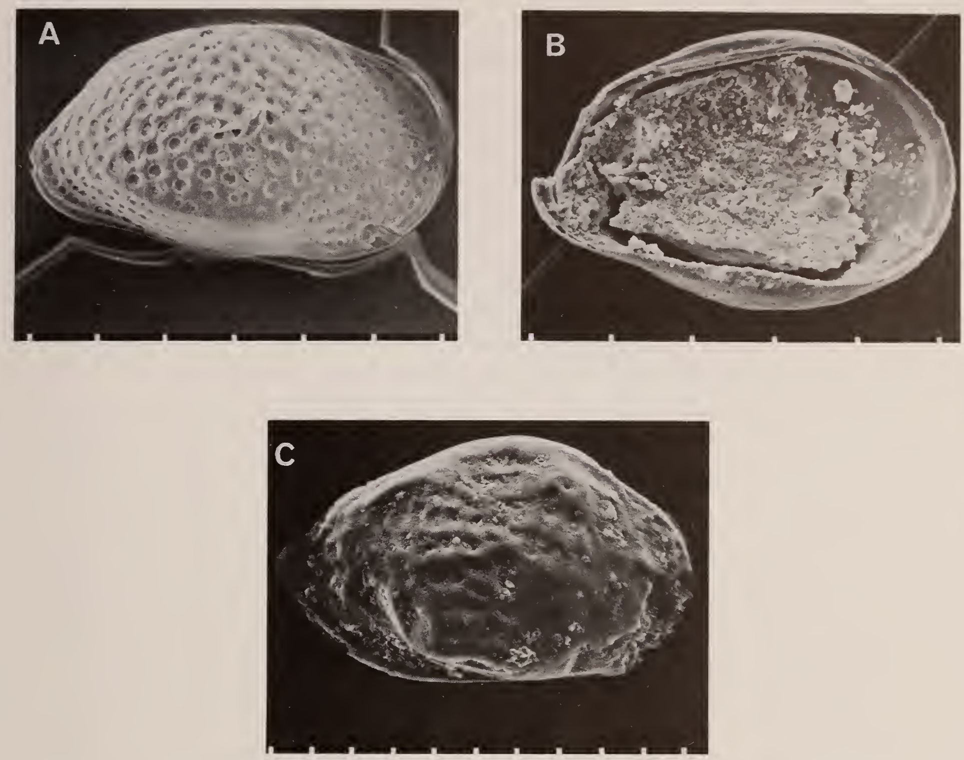


Fig. 36. A–B. Indet. sp. 327/16B, DSDP 327, core 16–4/68–70 cm, middle Albian. A. SAM–PC6127, RV. B. SAM–PC6126, LV internal view. C. Indet. sp. 327/18, SAM–PC6128, RV, DSDP 327, core 18–2/51–55 cm, middle Albian.
Scale bars: A–B = 100 μ, C = 30 μ.

DISCUSSION

All the ostracods encountered were benthic types, and 51 species belonging to 26 genera (with 6 species unallocated) were identified from the Aptian to Cenomanian strata of south-east Africa (Agulhas Bank and Zululand) and the Falkland Plateau (DSDP sites 327 and 330). In this section the faunas and their palaeoecological and biostratigraphical implications will be discussed, followed by a regional assessment of their distribution in the light of mid-Cretaceous palaeogeographic reconstructions of this part of Gondwanaland.

FALKLAND PLATEAU

Altogether 28 species belonging to 16 genera (with 4 species unallocated) have been recorded from the two DSDP sites on the east Falkland Plateau: site 327 (20 species, 14 genera); site 330 (17 species, 13 genera). Their vertical distribution and relative abundances are shown in Table 6.

Palaeoecology

Although a relatively rich fauna was obtained from DSDP site 330, only three samples contained specimens, and their limited vertical distribution (early–middle Albian, Fig. 4) makes the determination of palaeoecological trends uncertain. In contrast, the nine fossiliferous samples from site 327 span early to late Albian time (Fig. 4), and allow some preliminary palaeoeocological determinations to be attempted for comparison with those already available from Sliter (1977) and Scheibnerova (1981).

Figure 37 and Table 6 show various statistical data on species and higher taxal trends from DSDP 327. Throughout the section the populations are dominated by *Robsoniella falklandensis* (37–56% of total fauna), which is usually at least twice as abundant as the next most common type. Three species alternate in this secondary role: *Isocythereis sealensis* (0–10%); *Cytherella bensoni* (7–19%); and *Arculicythere tumida* (1–18%). The taxonomic position of *Robsoniella* is uncertain and, although it was originally placed in the family Healdiidae by Kusnetsova (in Mandelstam *et al.* 1956), the *Treatise* authors on ostracods (Moore 1961) were not happy about the situation. We have placed it in the Bairdiidae because of, *inter alia*, its similarity to *Bythocypris richardsbayensis* from the Upper Cretaceous of South Africa. *Bairdoppilata* sp. 2, the only other representative of the family, is locally fairly common, but does not occur consistently throughout the borehole.

Considering the various populations in terms of a Cytheracea–Cytherellidae–Bairdiacea + Cypridacea (CCBC) triangular diagram (Fig. 38) all, with the exception of one, lie in the 200–100 m water-depth field of the predictive CCBC plot of Dingle (1981, fig. 75). The exception (core 16–4/66–70 cm, sample 7) lies in the field predicted for water depths greater than 500 m. Dingle (1980, 1981) constructed this diagram from ostracod populations collected mainly from Zululand and, in terms of the assemblages originally plotted, all the Falkland Plateau populations lie outside them, or in one case (core 21–4/130–134 cm, sample 1) just inside the border (of assemblage 4a).

Figure 37 shows that the relative abundances of the three groups represented on the CCBC plot remain fairly constant up the borehole, suggesting that the overall sedimentary environment remained similar during the entire early to late Albian period represented by cores 21 to 15. This conclusion is in broad

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Fig. 37. Variations in selected components of the Albian ostracod populations at DSDP site 327 on the Falkland Plateau. a—higher taxa used in the Cytheracea, Cytherellidae, Bairdiacea + Cypridacea (CCBC) triangular diagram (Fig. 38) plotted as percentage of total ostracod population; b—four important genera plotted as percentage of total ostracod population; c—the subfamilies Cytherurinae and Trachyleberidinae (the genus *Isocythereis*) plotted as percentage of Cytheracea; d—micro-ostracods (see Table 6 for species) plotted as percentage of total ostracod population. The vertical scales on a–d are percentages, and values are smoothed using a three-point running mean; e—shows temporal distribution of minor species, numbered according to Table 5. Species with stars are also found at DSDP site 330. The horizontal scale is by core and informal sample number (see Table 6).

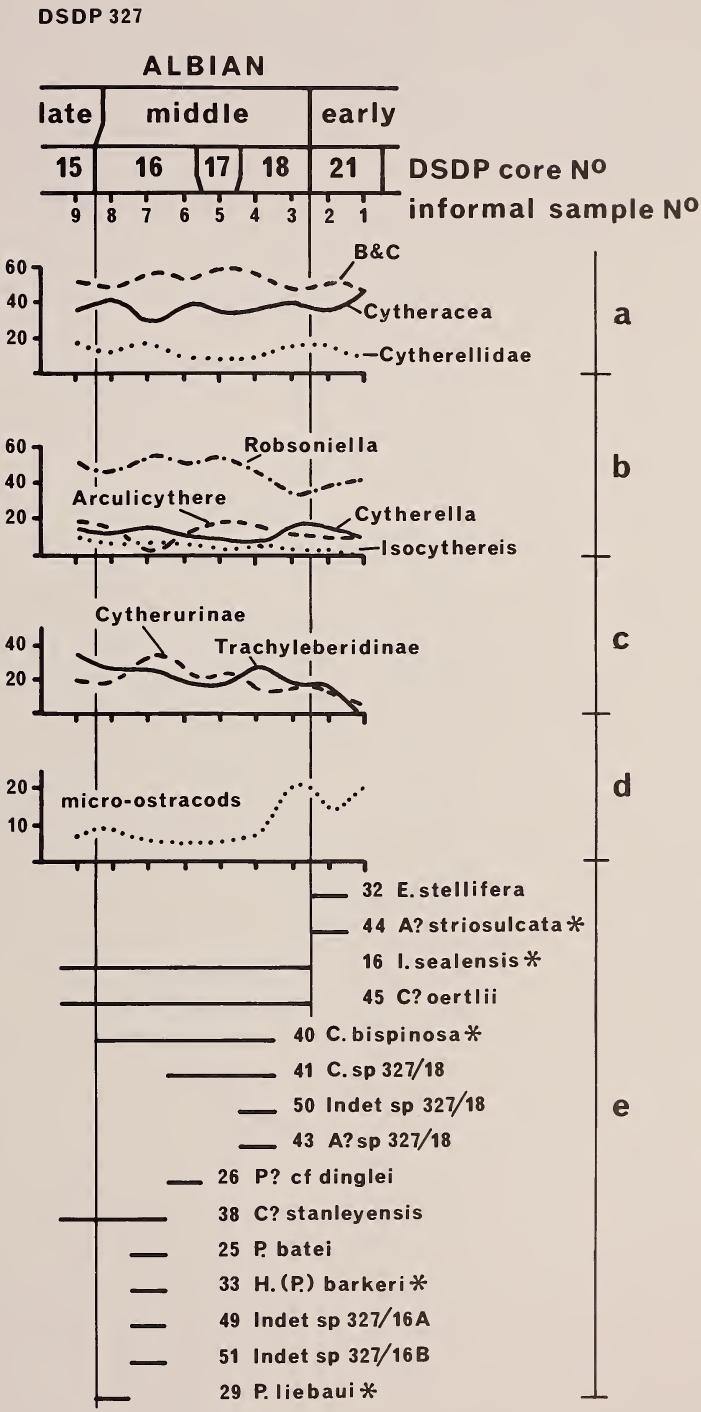
DSDP 327
ALBIAN
late
middle
early
15
16
17
18
21
DSDP core No
9 8 7 6 5 4 3 2 1
informal sample No
60
40
20
B&C
Cytheracea
Cytherellidae
a
60
40
20
Robsoniella
Arculicythere
Cytherella
Isocythereis
b
40
20
Cytherurinae
Trachyleberidinae
c
20
10
micro-ostracods
d
32 E. stellifera
44 A? striosulcata *
16 I. sealensis *
45 C? oertlii
40 C. bispinosa *
41 C. sp 327/18
50 Indet sp 327/18
43 A? sp 327/18
26 P? cf dinglei
38 C? stanleyensis
25 P. batei
33 H. (P.) barkeri *
49 Indet sp 327/16A
51 Indet sp 327/16B
29 P. liebaui *
e

TABLE 6

Distribution of ostracods in Albian sediments of DSDP sites 327 & 330, Falkland Plateau

Numbers in each column are percentages of total ostracod population.

Sp. no.	DSDP site no.	330			327									
	Age	early–middle Albian			early Albian		middle Albian						late Albian	Cenom
	Core no.	2	1		21		18		17	16			15	14
	section	2	1		4	3	6	2	2	6	4	1	2	6
	Interval (cm)	122–126	cc	112–116	130–134	71–76	106–110	51–55	108–113	126–130	66–70	55–59	132–136	126–130
	Informal sample no.	1	2	3	1	2	3	4	5	6	7	8	9	
25	*Procytherura batei*	3									18			*
15	*Arculicythere tumida*	38	34	24	22	8		22	29	3			35	*
9	*Robsoniella falklandensis*	54	19	32	70	15	38	59	50	61	42	63	38	*
1	*Cytherella bensoni*	5	1	15	5	15	22			23	6	19	8	*
29	*Pariceratina liebaui*		3	1								3		*
40	*Cytheropteron bispinosa*		13	10				3			6	3		*m
30	*Pedicythere falklandensis*		1	1										m
31	*Eucytherura rugosa*		1											m
35	*H. (Parahemingwayella) reticulata*		3	1										m
34	*H. (P.) dalzieli*		10	6										m
33	*H. (P.) barkeri*		3								3			*m
36	*Hemiparacytheridea ewingensis*		2											m
37	*H. challengeri*		1											m
39	*Asciocythere? dubia*		3											

7	*Bairdoppilata* sp. 2		2	9		8	22	3	—	3				*
16	*Isocythereis sealensis*			4			11	—	14	3	3	9	10	*
32	*Eucytherura stellifera*					8								m
45	*Cytherura? oertlii*						5	—	—	—	—	—	2	m
41	*Cytheropteron* sp. 327/18							3	—	3				m
43	*Aitkenicythere?* sp. 327/18							6						m
50	Indet. sp 327/18							3						
14	*Majungaella?* 327/16									3				
26	*Procytherura* cf. *dinglei*									3				
38	*Collisarboris? stanleyensis*										3	—	2	m
49	Indet. 327/16A										3			
51	Indet. 327/16B										6			
	Indet. species (various fragments)	2			5	15	22	—	—	23	6	19	8	
No. ostracod valves		37	119	110	37	13	37	32	14	31	33	32	48	0
No. spp./sample		4	16	11	4	6	5	7	3	8	9	5	6	0
Diversity (No. spp./100 valves, %)		11	13	10	11	46	14	22	21	26	27	16	13	0
No. spp./site			18							20				
Micro-ostracods: No. spp./sample		0	9	5	0	2	1	3	0	1	3	1	2	0
Micro-ostracos: % total ostracods		0	38	23	0	39	5	15	0	3	12	3	8	0
No. spp. extant (total ostracods)		4	16	11	3	6	6	10	8	10	11	8	6	0

Total no. of species = 28
No. common 327/330 = 10 (36% total)

Total no. of species of micro-ostracods = 14
No. common 327/330 = 3 (21%)

* = species common to both sites
m = micro-ostracod (<0,45 mm)

TABLE 6

Distribution of ostracods in Albian sediments of DSDP sites 327 & 330, Falkland Plateau
Numbers in each column are percentages of total ostracod population.

Sp. no.	DSDP site no.	330			327										
	Age	early–middle Albian			early Albian		middle Albian						late Albian	Cenom	
	Core no.	2	1		21		18		17	16			15	14	
	section	2	1		4	3	6	2	2	6	4	1	2	6	
	Interval (cm)	122–126	cc	112–116	130–134	71–76	106–110	51–55	108–113	126–130	66–70	55–59	132–136	126–130	
	Informal sample no.	1	2	3	1	2	3	4	5	6	7	8	9		
25	*Procytherura batei*	3									18				*
15	*Arculicythere tumida*	38	34	24	22	8		22	29	3			35		*
9	*Robsoniella falklandensis*	54	19	32	70	15	38	59	50	61	42	63	38		*
1	*Cytherella bensoni*	5	1	15	5	15	22			23	6	19	8		*
29	*Pariceratina liebaui*		3	1								3			*
40	*Cytheropteron bispinosa*		13	10				3			6	3			*m
30	*Pedicythere falklandensis*		1	1											m
31	*Eucytherura rugosa*		1												m
35	*H. (Parahemingwayella) reticulata*		3	1											m
34	*H. (P.) dalzieli*		10	6											m
33	*H. (P.) barkeri*		3								3				*m
36	*Hemiparacytheridea ewingensis*		2												m
37	*H. challengeri*		1												m
39	*Asciocythere? dubia*		3												
44	*Aitkenicythere? striosulcata*		4	5		31									*m
48	Indet. sp. 330/1		2												
7	*Bairdoppilata* sp. 2		2	9		8	22	3		3					*
16	*Isocythereis sealensis*			4			11		14	3	3	9	10		*
32	*Eucytherura stellifera*					8									m
45	*Cytherura? oertlii*						5						2		m
41	*Cytheropteron* sp. 327/18							3		3					m
43	*Aitkenicythere?* sp. 327/18							6							m
50	Indet. sp 327/18							3							
14	*Majungaella?* 327/16									3					
26	*Procytherura* cf. *dinglei*									3					
38	*Collisarboris? stanleyensis*										3		2		m
49	Indet. 327/16A										3				
51	Indet. 327/16B										6				
	Indet. species (various fragments)	2			5	15	22			23	6	19	8		
	No. ostracod valves	37	119	110	37	13	37	32	14	31	33	32	48	0	
	No. spp./sample	4	16	11	4	6	5	7	3	8	9	5	6	0	
	Diversity (No. spp./100 valves, %)	11	13	10	11	46	14	22	21	26	27	16	13	0	
	No. spp./site		18							20					
	Micro-ostracods: No. spp./sample	0	9	5	0	2	1	3	0	1	3	1	2	0	
	Micro-ostracos: % total ostracods	0	38	23	0	39	5	15	0	3	12	3	8	0	
	No. spp. extant (total ostracods)	4	16	11	3	6	6	10	8	10	11	8	6	0	

Total no. of species = 28
No. common 327/330 = 10 (36% total)

Total no. of species of micro-ostracods = 14
No. common 327/330 = 3 (21%)

* = species common to both sites
m = micro-ostracod (<0,45 mm)

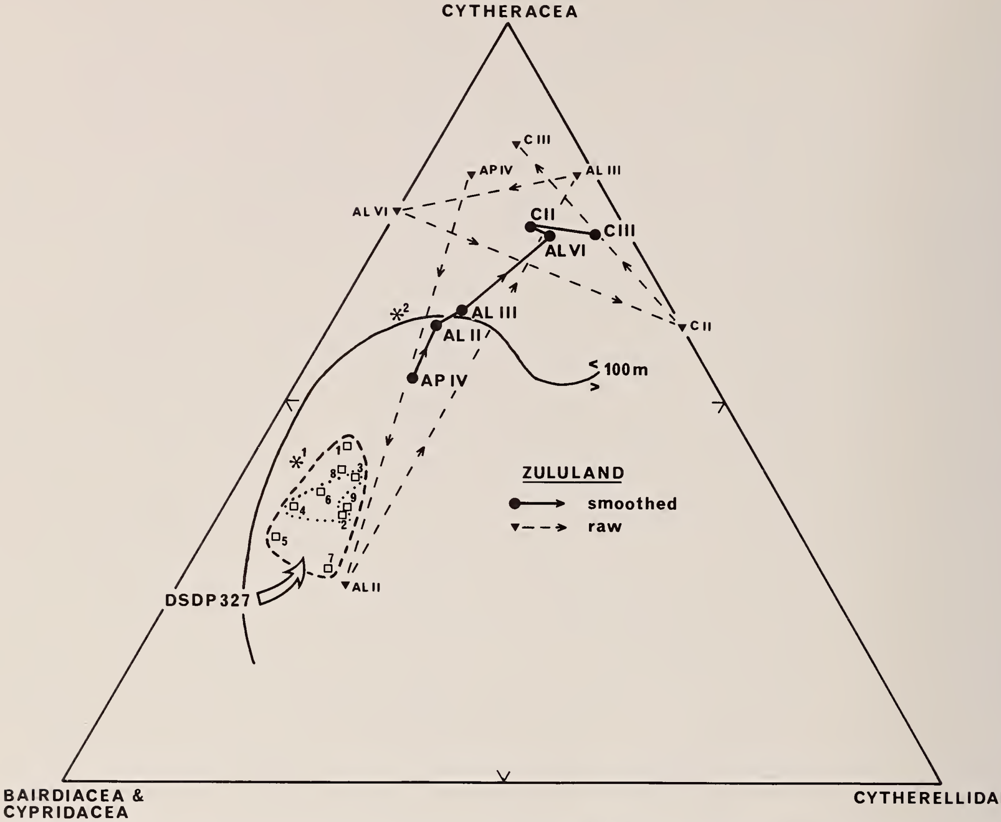

Fig. 38. Triangular (CCBC) plot of the mid-Cretaceous ostracod populations from the Falkland Plateau and Zululand. The DSDP samples are numbered using the informal system shown in Table 6 and are plotted smoothed (3 point means). Populations from site 327 are enclosed by a thick dashed line, and samples containing *Bairdoppilata* sp. 2 are enclosed by a dotted line. Samples from DSDP 330 are plotted as stars: *1 is sample 1, and *2 is a composite population from samples 1 and 2. Samples from Zululand are composites from stage subdivisions and are plotted both smoothed (3 point means), and raw. The 100 m predictive water depth line is taken from Dingle (1982, fig. 75). See text for a discussion of the trends. Abbreviations: AP—Aptian; AL—Albian; C—Cenomanian.

agreement with that reached by Barker *et al.* (1977), and Sliter (1977) on studies of the planktonic foraminifera, which predicted water depths of 100–400 m from the Albian sequence (Barker *el al.* 1977: 44, fig. 7). Sliter (1977: 524) detected a slight reduction in benthic foraminifera numbers up the borehole (cores 21 to 15), which he interpreted as a gradually increasing water depth, as well as an increase in the numbers of planktonic foraminifera from their incoming (few specimens) in core 19, to 35 per cent of total biogenic debris at the base of core 16, with a further rise, after fluctuation to 45 per cent in core 15. Planktonic–benthic foraminiferal ratios calculated from Sliter's (1977) data (Fig. 39) indicate an erratic increase from core 19 (*c.* 0,5, middle Albian) to core 15 (3,46, late Albian). Above this (Cenomanian and Santonian), planktonic foraminifera are very sparse or absent before rising to values of greater than 9,0 in the Campanian–Maastrichtian, which Sliter interprets as representing water depths of 1 500–2 500 m.

Figure 39 shows the planktonic–benthic ratio curve (a) plotted against various trends of the ostracod populations. Planktonic foraminifera appear in core 19 and there are three peaks in the curve above this point. In comparison, the curve of cytheracean ostracods (b) (as percentage of total fauna) shows four high points, and two of these are in, and two out of phase with the foraminiferal peaks. Each of the cytheracean peaks can be related to the dominance of particular higher taxa: the earliest (core 21) is caused by relatively large numbers of micro-ostracods (c) and lies below the level of the appearance of planktonic foraminifera; the second (core 17) lies between two peaks in the planktonic–benthic curve and is related to the large numbers of *Isocythereis sealensis* and *Arculicythere tumida* present at this level (d, e). A peak in the curve for the micro-ostracod distribution does coincide with the first foraminifera peak in core 18, and similarly in core 16 where the numbers of micro-ostracods involved is large enough to result in a peak in the cytheracean curve. At this level there is a low in the values for both *Isocythereis sealensis* and *Arculicythere tumida*. In core 15, the cytheracean peak, which coincides with a peak in the P/B curve, is caused by reinforcement of curves (c), (d), and (e). It appears, therefore, that fluctuations in the percentage of the cytheracean element were caused by alternation in the numbers of micro-ostracods (mostly cytherurids) and combined trachyleberids and progonocytherids, and that neither were consistently in step with increases in the relative numbers of planktonic foraminifera. Consequently, the latter are more likely to reflect changes in degree of access to the open ocean than significant alternations of local sea-level.

Scheibnerova (1981) studied the Albian benthic foraminfera of site 327 and found a relatively rich assemblage of agglutinated and calcareous benthic forms (Table 7), which indicated to her a water depth in the vicinity of 100 m (not exceeding 300–400 m).

The results of plotting the ostracod data from site 330 on to the CCBC diagram (Fig. 38) suggest shallow-water environments in both cases, with the oldest sample (core 2–2/122–126 cm) lying close to the cluster from site 327, and probably representing somewhat shallower water (*c.* 100 m). A mean value for the two samples in core 1 places it within the shallow water (less than 100 m) field of the cytheracean-dominated populations. Although too few samples are available from site 330 for a reliable estimate of palaeoenvironments to be made, the evidence does point to deposition under similar conditions to those that prevailed at the same time (early–middle Albian) at site 327 (*c.* 10 km to the south-west).

Micro-ostracods ($<$ 0,45 mm) (Table 6) are both diverse and relatively abundant in the mid-Cretaceous at site 327 (and 330), and show variations along the length of the hole that may have palaeoenvironmental significance. They are

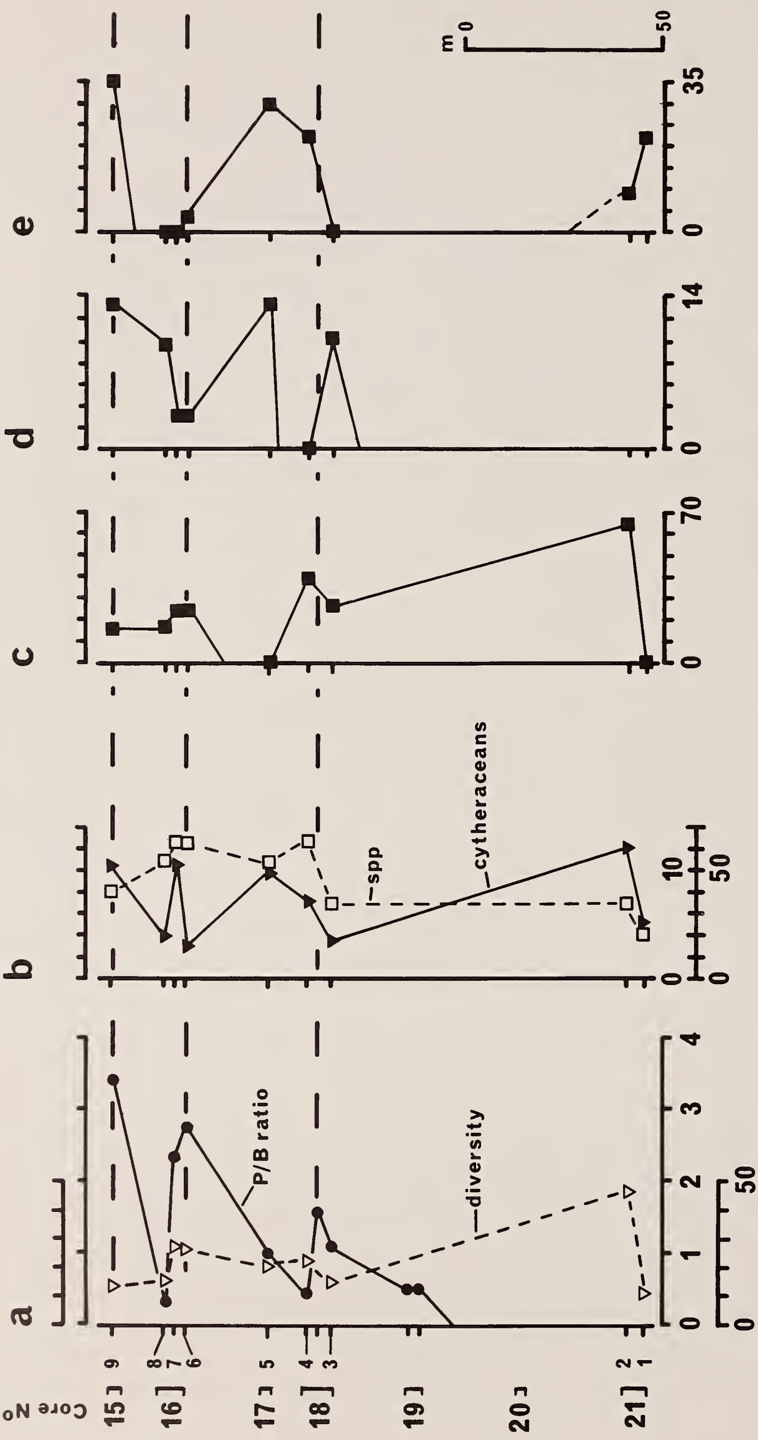

Fig. 39. Distribution of various microfaunal elements in the Albian strata of DSDP site 327.

Vertical scale is in metres, and left column shows core and informal sample numbers (see Table 6 for core section correlation). a—Dots: planktonic/benthic foraminifera ratio calculated from data given in Sliter (1977). The three peaks in this curve run across the whole diagram as dashed lines. Inner horizontal scale refers and is a ratio. Open triangles: ostracod population diversity (no. spp. per 100 specimens). Outer horizontal scale refers and is a percentage. b—Open squares: number of ostracod species extant. Inner horizontal scale refers and is no. spp. Solid triangles: number of cytheracean specimens as percentage of total ostracod fauna. Outer horizontal scale refers and is a percentage. c—Number of micro-ostracod specimens as percentage of cytheracean element. d—Number of specimens of *Isocythereis sealensis* as percentage of total ostracod fauna. e—Number of specimens of *Arculicythere tumida* as percentage of total ostracod fauna.

TABLE 7
Characteristic benthic foraminifera from cores 26 to 16 at DSDP site 327 (after Scheibnerova 1981).

Discorbis sp.
Pseudopatellinella howchini
Osangularia utaturensis
Anomalina indica
Gavelinella intermedia
Lingulogavelinella sp.
L. frankei africana
Orithostella indica
Pseudolamarckina sp.
Reinholdella claytonensis
Hoeglundina australiensis
*Rotaliatina asiatica***
*Hergottella jonesi***

** only in cores 20 to 16.

mostly small species belonging to the subfamily Cytherurinae (*Cytherura, Eucytherura, Cytheropteron, Hemingwayella (Parahemingwayella), Hemiparacytheridea, Pedicythere)* (Table 8) but others (*Collisarboris?* and *Aitkenicythere?*) belong to different higher taxa, and Figures 37c–d and 39(c) express these trends as: Cytherurinae as percentage of cytheraceans; micro-ostracods as percentage of total ostracods; and micro-ostracods as percentage of cytheraceans, respectively. From Figure 37 it can be seen that micro-ostracods constitute an important component of the total ostracod population in the lower parts of the sequence (*c.* 15–20%), but that higher up they are less numerous (*c.* 5–10%). A similar trend is shown in Figure 39, where the percentage of the cytheracean component shows erratic high and low values (0–65%) below core 16, and steadier values of 25% or less higher up. This suggest that in cores 21–17 palaeoenvironments conducive to micro-ostracod colonization fluctuated from highly suitable to completely unsuitable, whereas in cores 16–15 conditions were moderately suitable. The smoothed Cytherurinae curve (Fig. 37c) shows that the consistently most suitable conditions occurred during the deposition of core 16. We suggest that these trends could indicate an early period (early–middle Albian) during which palaeoenvironments fluctuated from 'hostile' (possibly restricted circulation, or even mildly anoxic, i.e. no micro-ostracods) to 'somewhat hostile' (abundant micro-ostracods), and that these passed upwards (middle–late Albian) into palaeoenvironments that were more suitable to other cytheraceans (such as *Isocythereis*) and supported only small micro-ostracod populations. Such fluctuations may have been affected by changing palaeogeographies and incursions of water from the isolated South Atlantic basin where Bolli *et al.* (1978) reported dwarf molluscs and sparse arenaceous foraminiferal faunas of Lower to Middle Albian age in the deep-water Cape Basin to the north of the Falkland Plateau.

To summarize, it is postulated that the ostracod populations of samples 2 to 6 (cores 21 to 16, which coincide with the occurrence of *Bairdoppilata* sp. 2) were deposited in water depths of about 200 m, with sample 1 (base of core 21,

TABLE 8
Distribution of Cytheruridae in the Falkland Plateau DSDP 327 and 330 samples
(% total ostracods)

DSDP site nos.	330			327									
Informal samples nos.	1	2	3	1	2	3	4	5	6	7	8	9	
Cytherura? oertlii						5—	—	—	—	—	—	—2	m
Eucytherura rugosa		1											m
E. stellifera					8								m
Procytherura cf. *dinglei*									3				
P. batei	3									18			
Cytheropteron bispinosa		13—	—10				3—	—	—	—6—	—3		m
Indet. sp. 327/18(?)							3						
H. (Parahemingwayella) barkeri		3								3			m
H. (P.) dalzieli		10—	—6										m
H. (P.) reticulata		3—	—1										m
Hemiparacytheridea ewingensis		2											m
H. challengeri		1											m
Pedicythere falklandensis		1—	—1										m
% total ostracods	3	34	18	—	8	5	6	—	3	27	3	2	
% cytheraceans (raw)	7	44	41	—	13	26	16	—	20	69	20	4	
% cytheraceans (smooth)				7	13	18	14	12	30	36	31	12	

m = micro-ostracods
(?) = taxonomic position in family uncertain

early Albian) probably in somewhat shallower water (100–200 m), and sample 7 (middle of core 16, top part of middle Albian) possibly somewhat deeper water (?500 m). Samples 8 and 9 (uppermost middle Albian and late Albian) suggest a return to water depths of about 200 m. Restricted bottom circulation (possibly accompanied by mildly anoxic conditions) may have occurred at the levels of samples 1 to 5 (bottom part of the middle Albian). The energy of sedimentary environments was low throughout the Albian section.

Biostratigraphy

Figure 37 and Tables 6 and 9 show the vertical distribution of Albian ostracod species at DSDP sites 327 and 330. Because of the limited range covered by the samples from 330, the distribution of the eight species restricted to it cannot be assessed: *Pedicythere falklandensis, Eucytherura rugosa, H. (Parahemingwayella) dalzieli, H. (P.) reticulata, Hemiparacytheridea ewingensis, H. challengeri, Asciocythere? dubia*, and indet. sp. 330/1.

At site 327, the nine fossiliferous samples available probably cover most of the Albian and, despite the small numbers of specimens recovered, certain trends are evident. Because of the relatively large numbers of *Robsoniella falklandensis*, the early to late Albian ostracod populations of site 327 are bairdiacian-dominant. The cytheracean element, on the other hand, is quite diverse (fourteen genera, twenty-one species) although certain taxa (e.g. *Arculicythere tumida*, and *Isocythereis sealensis*) locally constitute up to 30% of this component.

Within the Cytheracea various higher taxa are unevenly distributed both in time and in lower taxonomic categories. The Cytherurinae show the greatest diversity (seven genera and thirteen species), and locally are numerically dominant, whereas the Trachyleberidinae is represented by one species only *(Isocythereis sealensis)*, and the Progonocytheridae by two species *(Majungaella?* sp. 327/16 and *Arculicythere tumida)*.

The diversity, local abundance, and small size of representatives of the subfamily Cytherurinae is one of the characteristics of the Albian strata of sites 327 and 330, particularly the dominance of micro-ostracods (*c.* 0,45 mm or less in length) (Table 8). This is particularly so at site 330 (core 1/cc) and site 327 (core 21–3), where 38% and 39%, respectively of the total ostracod population falls into this category. Some of the species occur at one horizon only, while others are found at several levels, where they locally make up a disproportionately large percentage of the total ostracod fauna: *Aitkenicythere? striosulcata*—31% in 327:21–3; *Cytheropteron bispinosa*—13% in 330:1/cc; and *Hemingwayella (Parahemingwayella) dalzieli*—10% in 330:1/cc. Despite the diversity of the micro-ostracods (11 out of 14 species belong to the Cytherurinae), with 9 species in 330 and 8 species in 327, only 3 species from a total of 14 (i.e. 21%) are common to both sites. Similarly, from the 8 genera involved, only 4 are common to the two sites, with *Pedicythere* and *Hemiparacytheridea* restricted to site 330, and *Collisarboris?* and *Cytherura?* restricted to site 327. All four of the last-named genera are widely distributed in the Northern Hemisphere, as well as Australia, so their restriction to either of the DSDP sites must be the result of chance sampling or subtle palaeoenvironmental differences.

The essential biostratigraphic features of the Albian ostracod fauna at site 327 can be summarized:

1. Numerous species of locally short-ranging, but frequently abundant micro-ostracods (overwhelmingly cytherurids).

2. Four long-ranging, numerically abundant species, three of which are widely distributed in mid-Cretaceous Gondwanide sediments: *Arculicythere tumida, Isocythereis sealensis, Robsoniella falklandensis,* and *Cytherella bensoni.* The first two in this list will probably turn out to be useful age diagnostic taxa, and further comment will be made when a comparison is made between the various regions under review.

A breakdown of the temporal distribution of the minor taxa is summarized in Figure 37 and Table 9. These show that two species are restricted to the early Albian, and eleven to the middle Albian, with the remainder ranging middle to late, and early to middle Albian. These ranges cannot be absolute, however, because, for example *Cytheropteron bispinosa* (middle Albian) occurs in core 1 at site 330, as does *Aitkenicythere? striosulcata* (early Albian only at 327). In this category, two species only are known from another area of Gondwanaland, *Aitkenicythere?* sp. 327/18 and *Cytherura? oertlii*, both of which occur off north-western Australia.

TABLE 9
Ranges of ostracods in DSDP 327.

Restricted to:		
late Albian	— none	
middle Albian	— *Majungaella?* 327/16	(14)
	Procytherura batei	(25)
	P. cf. *dinglei*	(26)
	Pariceratina liebaui	(29)
	H. (Parahemingwayella) barkeri	(33)
	Cytheropteron bispinosa	(40)
	C. sp. 327/18	(41)
	Aitkenicythere? sp. 327/18	(43)
	Indet. sp. 327/16A	(49)
	Indet. sp. 327/18	(50)
	Indet. sp. 327/16B	(51)
early Albian	— *Eucytherura stellifera*	(32)
	Aitkenicythere? striosulcata	(44)
middle to late Albian	— *Isocythereis sealensis*	(16)
	Collisarboris? stanleyensis	(38)
	Cytherura? oertlii	(45)
early to middle Albian	— *Bairdoppilata* sp. 2	(7)

Numbers in right-hand column refer to species numbers in Table 5.

SOUTH-EAST AFRICA

Twenty-five species belonging to sixteen genera (with two species unallocated) have been recorded from the Aptian to Cenomanian strata of south-east Africa. The bulk of these (nineteen species in thirteen genera) are from the Zululand area, where relatively large numbers of specimens were collected from rocks that range in age from Aptian to Cenomanian. Collections from the Outeniqua Basin consist of two samples only (TBD 1113 and 1266), which probably have a range restricted to Upper Aptian–Albian. One species only (*Sondagella theloides*) is common to these two areas in mid-Cretaceous material, although a further two species (*Majungaella nematis* and *M? hemigymnae*) are common in pre-Aptian strata. The distribution of these faunas is shown in Tables 5 and 10.

ZULULAND

Palaeoecology

In Zululand a total of 21 samples yielded ostracods, but because some of these faunas were too small to handle on a CCBC diagram, populations from individual ammonite stages were summed (Table 10) before plotting on Figure 38. The resultant small number of data points, based on disparate numbers of samples, gives rise to two alternative plots depending on whether raw or smoothed data are used. The latter type have usually proved most successful in previous studies (Dingle 1980, 1981), but are probably less suitable in the present case because the populations have already been summed once to provide the stage assemblages. Both alternatives are shown in Figures 38 and 40.

Using smoothed data, the earliest populations (Aptian IV) lie within the field predicting water depths of 100–200 m (the 4a populations of Dingle 1981, figs 68 and 75). This plots as the deepest water population encountered in the Zululand mid-Cretaceous, and younger populations suggest progressively shallower water depths and higher energies of the sedimentary environments: Albian III and Albian IV populations lie above the 'Cytheracea line' and just within the <100 m predictive field; and the Albian IV and Cenomanian II and III populations lie within the high-energy sector of the <100 m predictive field (Dingle 1980, fig. 33; 1981, fig. 75).

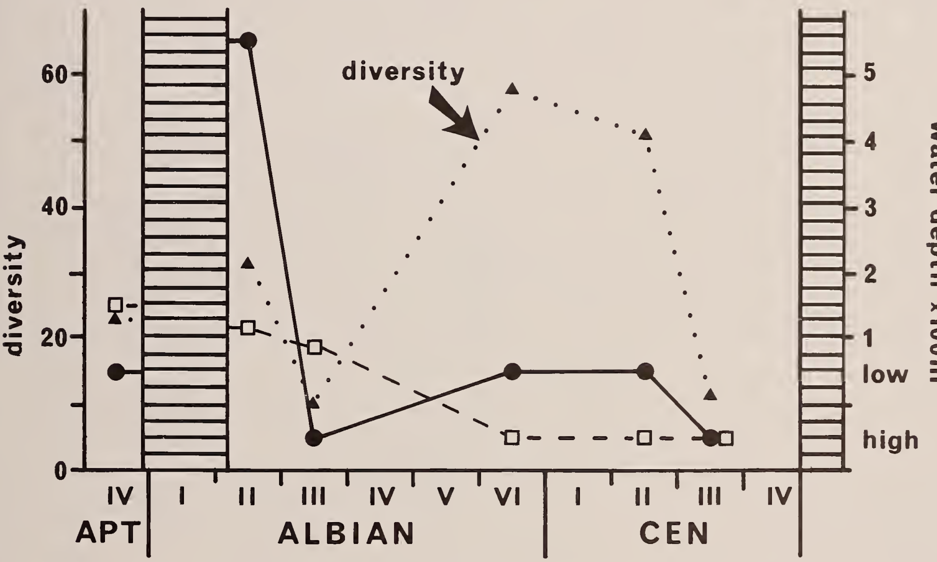

Fig. 40. Predictive water depths for mid-Cretaceous stages in Zululand. Based on the CCBC triangular diagram in Figure 38. Open squares—smoothed data (3 point mean); solid circles—raw data. Water depths <100 m are differentiated into high- and low-energy environments (as defined by Dingle 1980, fig. 33B). Faunal diversity of ostracod populations (raw data) is shown in solid triangles as a percentage (number of species per 100 specimens). Note that Albian I strata are missing at outcrop where the Makatini Formation is unconformably overlain by the Mzinene Formation. Non-sequences shown as horizontal ruling.

Using raw data, on the other hand, the Aptian IV population lies within the low-energy sector of the <100 m water-depth field, while Albian II assemblages, which appeared after the late Aptian to Albian I hiatus, plot within the upper part of the >500 m water depth field. A relatively rapid change to shallow-water (<100 m), high-energy environments is suggested by the Albian III populations, and a further change to low-energy shallow-water (<100 m) conditions is indicated by the Albian VI data point on the Cytheracea–Bairdiacia+Cypridacea

TABLE 10

Mid-Cretaceous ostracods of south-east Africa

(a) Distribution of ostracods in mid-Cretaceous of Zululand (% total fauna)

Ammonite zones (Kennedy & Klinger 1975)	Barr	Aptian I	Aptian II	Aptian III	Aptian IV	Albian II	Albian III	Albian IV	Albian V	Albian VI	Cenomanian I	Cenomanian II	Cenomanian III	Cenomanian IV	
Sample nos.				1	2	3	4			5		6	7		Sp. no.
Indet. sp. 1				x											46
Pirileberis makatiniensis					4		9								19
Paracypris sp.					6	55	2			25			8		8
Indet sp. 2					6										47
Cytherella sp.					4	19	16					20	8		2
Pirileberis mkuzensis					8		22								20
Makatinella inflata					4		30								21
Majungaella nematis					13		2					10			12
M? hemigymnae					2										13
Pongolacythere striata					21		1								23
Bairdoppilata sp. 1					8										6
Makatinella tritumida					6	9	3					10	16		22
Cytherelloidea makatiniensis					2		2								4
Procytherura cf. *aerodynamica*					2										24
**Sondagella theloides*							12								10

Cytherelloidea ndumuensis						20		5
Indet cytheraceans		4						
Indet smooth forms		3	18	3	13	10		
No. valves	2	53	11	117	8	10	25	19 spp. 13 gen.

(b) Agulhas Bank area (Outeniqua Basin)

Sample TBD 1113 (Middle–Upper Albian)		Sample TBD 1266 (Upper Aptian–Albian)		
Arculicythere tumida	46%	*Cytherelloidea agulhasensis*	lv	
**Sondagella theloides*	45%	*Cythereis agulhasensis*	lv	
Isocythereis sealensis	5%	*Majungaella* cf. *queenslandensis*	lv	
Majungaella cf. *queenslandensis*	3%			
Cytheropteron? sp.	1%			
No. valves = 92		No. valves = 3		7 spp, 7 gen.
				25 spp, 16 gen.

* common to Outeniqua Basin and Zululand

(c) Similarity in Zululand

Aptian 14 spp. 11 gen.
Albian 13 spp. 11 gen. } 18 spp., 9 common = 50%

Cenomanian 6 spp, 6 gen. } 14 spp., 5 common = 30%

TABLE 10

Mid-Cretaceous ostracods of south-east Africa

(a) Distribution of ostracods in mid-Cretaceous of Zululand (% total fauna)

	Barr	Aptian				Albian					Cenomanian				
Ammonite zones (Kennedy & Klinger 1975)		I	II	III	IV	II	III	IV	V	VI	I	II	III	IV	
Sample nos.				1	2	3	4			5		6	7		Sp. no.
Indet. sp. 1				x											46
Pirileberis makatiniensis					4		9								19
Paracypris sp.					6	55	2			25			8		8
Indet sp. 2					6										47
Cytherella sp.					4	19	16					20	8		2
Pirileberis mkuzensis					8		22								20
Makatinella inflata					4		30								21
Majungaella nematis					13		2					10			12
M? hemigymnae					2										13
Pongolacythere striata					21		1								23
Bairdoppilata sp. 1					8										6
Makatinella tritumida					6	9	3					10	16		22
Cytherelloidea makatiniensis					2		2								4
Procytherura cf. *aerodynamica*					2										24
**Sondagella theloides*							12								10
Sphaeroleberis? sp. A							3			13					27
Monoceratina? sp.										13					28
Isocythereis? ndumuensis										38		30	68		17
Cytherelloidea ndumuensis												20			5
Indet cytheraceans					4										
Indet smooth forms					3	18	3			13		10			
No. valves				2	53	11	117			8		10	25		19 spp. 13 gen.

(b) Agulhas Bank area (Outeniqua Basin)

Sample TBD 1113 (Middle–Upper Albian)		Sample TBD 1266 (Upper Aptian–Albian)		
Arculicythere tumida	46%	*Cytherelloidea agulhasensis*	lv	
**Sondagella theloides*	45%	*Cythereis agulhasensis*	lv	
Isocythereis sealensis	5%	*Majungaella* cf. *queenslandensis*	lv	
Majungaella cf. *queenslandensis*	3%			
Cytheropteron? sp.	1%			
No. valves = 92		No. valves = 3		7 spp, 7 gen.
				25 spp, 16 gen.

* common to Outeniqua Basin and Zululand

(c) Similarity in Zululand

Aptian 14 spp. 11 gen. Albian 13 spp. 11 gen.	18 spp., 9 common = 50%
Cenomanian 6 spp, 6 gen.	14 spp., 5 common = 30%

base line. A deepening and increase in environmental energy is suggested for the Cenomanian II populations that lie close to the predictive 100 m water-depth line, while a shallow-water (<100 m), high-energy environment is indicated by the Cenomanian III population. Figure 40 summarizes the water-depth predictions from these two data sets, and shows that the most substantial difference is the water depth of Albian II deposition following the hiatus that separates the Makatini and Mzinene formations. With the exception of this point on the 'raw data' plot, and the Aptian IV point on the 'smoothed data' plot, all other points lie within the field predictive of water depths (<100 m), although there is disparity in assessing environmental energy.

In summary, we suspect that the depositional environments of all the stages shown in Figure 40, with the exception of Albian II, were in water depths of <100 m, with that of the Cenomanian III, at least, in relatively high-energy conditions prior to the commencement of the local Cenomanian IV to Coniacian hiatus. The Albian II populations, which re-colonized the area after the late Aptian to early Albian hiatus, were probably dominated by *Cytherella* and *Paracypris*, and suggest water depths in excess of 200 m (the value of >500 m indicated by one data set on the CCBC diagram may be biased because of the small assemblage available for study).

Table 11 shows some of the population characteristics of the mid-Cretaceous strata of Zululand, and it is significant that, except in Albian II, cytheraceans invariably comprise the dominant (>20%) elements in the assemblage, and in particular that *Isocythereis? ndumuensis* is a dominant species for Albian VI to Cenomanian III time. A further point to note is the relatively low faunal diversity suggested for Albian III and Cenomanian III assemblages, both of which are predicted to lie in the higher-energy shallow-water field of the CCBC diagram (Fig. 38, 'raw data' plot).

Biostratigraphy

The temporal ranges of ostracods found in the Zululand mid-Cretaceous rocks are shown in Tables 1, 10, and 12. In the cytheracean components two groups can be distinguished: those that are known only from Zululand, and those that have been recorded from other localities in south-east Africa and Gondwanaland. The latter comprises *Majungaella nematis* and *Sondagella theloides*, which range upwards into Cenomanian II and Albian III, respectively. These are the youngest records of the two species, both of which have extensive temporal and spatial ranges outside the south-east African region.

Faunal diversity in the various stages is shown in Table 11, but some of the values are probably not meaningful because of the small numbers of specimens involved in certain samples, in particular the high diversity recorded for Albian VI and Cenomanian II. An aspect that is probably significant is the similarity and relatively high diversity in the Aptian IV and Albian II populations, where there are several apparently short-range cytheracean taxa such as *Makatinella inflata, Pongolacythere striata*, and two species of *Pirileberis* (*makatiniensis* and

TABLE 11
Population characteristics and suggested palaeoenvironments, mid-Cretaceous of Zululand.

	Aptian IV	Albian II	Albian III	Albian VI	Cenomanian II	Cenomanian III
dominant >20 %	*P. striata*	*Paracypris* sp.	*P. mkuzensis* *M. inflata*	*I? ndumuensis* *Paracypris* sp.	*I? ndumuensis* *Cytherella* sp. *C. ndumuensis*	*I?ndumuensis*
secondary >10 %	*M. nematis*	*Cytherella* sp.	*Cytherella* sp. *S. theloides*			*M. tritumida*
tertiary >5 %	*P. mkuzensis* *M. tritumida*	*M. tritumida*	*P. makatiniensis*			
suggested palaeo-environments	shallow water, <100 m	moderate to deep water, ?>200 m	shallow water, <100 m	shallow water, <100 m	shallow water, <100 m	shallow water, <100 m, high energy
faunal diversity (no. spp./100 spec.)	32 %	32 %	10 %	63 %	56 %	16 %

TABLE 12
Temporal distribution of mid-Cretaceous cytheracean ostracods from Zululand.

(a) Confined to Aptian:
Indet. sp. 1
Indet. sp. 2
Majungaella ?hemigymnae
Procytherura cf. *aerodynamica*

(b) Confined to Albian:
Sphaeroleberis? sp.
Monoceratina? sp.

(c) Confined to Cenomanian:
Cytherelloidea ndumuensis

(d) Confined to Mzinene Formation (Albian–Cenomanian):
Sphaeroleberis? sp.
Monoceratina? sp.
Isocythereis? ndumuensis
Cytherelloidea ndumuensis

mkuzensis). It appears that despite the hiatus between the Makatini and Mzinene formations (Albian I is missing), there was faunal continuity in the ostracod populations across the Aptian–Albian boundary. This is shown by a 50 per cent similarity level in all ostracod taxa between Aptian and Albian strata (Table 10). In contrast our evidence, although slender, does point to the establishment, by at least the end of Albian III times, of an Albian–Cenomanian assemblage whose most diagnostic element so far recognized is *Isocythereis? ndumuensis*. A similarity index of only 36 per cent is found in the total fauna between the Albian and Cenomanian strata (Table 10). *Makatinella tritumida*, an easily recognized taxon, is the only member of the endemic cytheracean group known to range from Aptian IV to Cenomanian III. From these Zululand mid-

Cretaceous ostracod populations no species is known to extend into the overlying St. Lucia Formation (Coniacian at outcrop, Turonian at subcrop), indicating a major faunal discontinuity between the mid-Cretaceous and Upper Cretaceous strata.

OUTENIQUA BASIN

Of the two samples from the Agulhas Bank, only TBD 1113 contains a large ostracod fauna (ninety-two valves), and this is composed entirely of cytheracean types, with *Arculicythere tumida* (46 %) and *Sondagella theloides* (45 %) the dominant taxa (Table 10). We have no other similar populations with which to make a comparison, and the known environmental preferences of the two dominant taxa appear to be at variance. *Arculicythere tumida* occurs in DSDP 259, 327 and 330, and in all cases was probably deposited in water depths of *c*. 200 m, whereas previous records of *Sondagella theloides* have been from strata that were probably deposited in relatively shallow, near-shore conditions (e.g. Algoa Basin where arenaceous foraminifera, wood fragments, and ostreids are common (Brenner & Oertli 1976)). Their mutual presence in sample TBD 1113 may indicate that each species was near the limit of its own environmental tolerance, but the anomalous aspect of this conclusion is that both occur in relatively large numbers. The fact that *Isocythereis sealensis* also occurs in DSDP 327 in samples that suggest deposition in water depths of *c*. 200 m (where it makes up 3 to 14 % of the fauna), and is present in small numbers (5 %) in TBD 1113, indicates that it is probably *Sondagella theloides* that has a greater water depth tolerance than previously suspected.

REGIONAL CONSIDERATIONS

During the time interval with which we are concerned, the palaeogeography of this part of Gondwanaland underwent significant changes. Reconstructions are shown in Figure 42 (a and b) (pre-breakup Valanginian, and middle Albian–Cenomanian, respectively). It is essential to consider the regional spatial and temporal distribution of the various taxa in terms of these palaeogeographies because they change from essentially intercontinental shelf seas (pre-breakup) to continental margin seas separated by deep ocean basins (Cenomanian). In addition, it must be borne in mind that there was no connection between the north and south sectors of the Atlantic Ocean across the Walvis Ridge before late Cenomanian–early Turonian times, and that the mid-Cretaceous ostracod populations with which we are concerned can be seen as the last representatives of an Upper Jurassic to Cenomanian ostracod faunal province within South Gondwanaland seas (Dingle 1982; Tambareau 1982). Figure 41 is a range chart for mid-Cretaceous ostracods that are common to more than one of the regions in Figure 42, or have close relatives elsewhere in South Gondwanaland.

Dingle (1982) has given details of the whole pre-Aptian South Gondwanaland ostracod fauna, but here it is relevant to emphasize the distribution of two

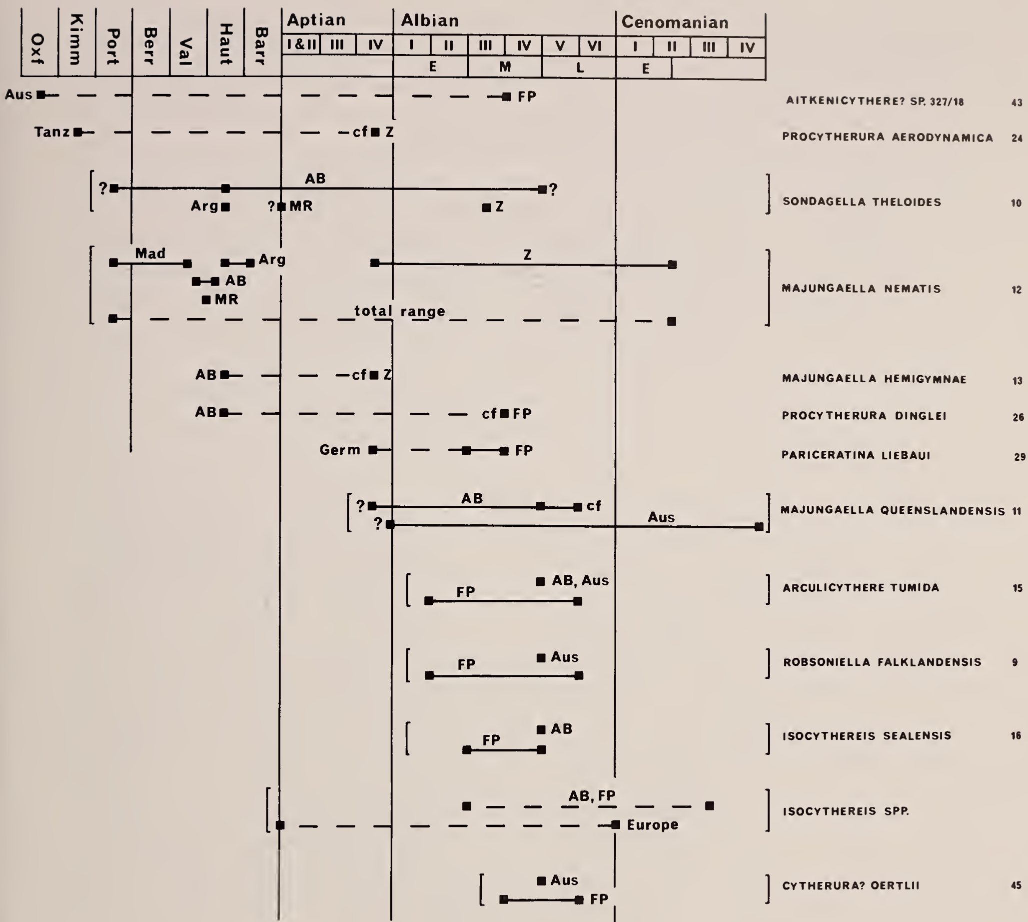

Fig. 41. Spatial and temporal distribution of selected species of ostracods in the mid-Cretaceous of south-east Africa and the Falkland Plateau, and adjacent Gondwanide localities. For comparison some distributions in more distant areas and pre mid-Cretaceous horizons are also noted. Dashed lines show total range from different geographical localities, solid lines are total ranges within one locality. Numbers on right-hand side are informal sample numbers used in Table 5. The Aptian to Cenomanian stages are those of Kennedy & Klinger (1975), and correlation with early, middle, and late subdivisions of DSDP (Barker *et al.* 1977) are nominal. See text for range citations. Abbreviations: Aus—Australia; FP—Falkland Plateau; Tanz—Tanzania; Z—Zululand; AB—Agulhas Bank, Arg—Argentina; MR—Mozambique Ridge; Mad—Madagascar; Germ.—Germany.

important species in terms of a pre-drift Valanginian palaeogeography (Fig. 42a). In this reconstruction, which is meant to illustrate the period immediately prior to, and immediately after, drifting in the Natal Valley–South Atlantic, conditions of no sedimentation or very slow anoxic sedimentation obtained over the DSDP sites (327 and 330) of the southern Maurice Ewing Bank: no ostracods were recovered from the Kimmeridgian–Aptian condensed sequences (or non-sequences) developed during this period. However, because the Agulhas Bank, Mozambique Ridge (DSDP 249), and Madagascar (Majunga Basin) are all characterized by the presence of *Majungaella nematis*, a shallow sea-way must have bypassed the Maurice Ewing Bank on its southern and, possibly, northern flanks. The latter route is suggested by the presence of marine strata of suspected Valanginian–Hauterivian age on the Transkei coast at Mngazana (McLachlan *et al.* 1976*a*). The Zululand–South Mozambique region lay to the west of the coastline at this time because pre-Upper Barremian marine sediments are unknown from the area.

Majungaella nematis also occurs in Hauterivian sediments in the Neuquen Basin of west central Argentina (Figs 1, 42a), which, with the presence of *Sondagella theloides*, indicates a connection with the Agulhas Bank area. Whether this connection actually lay across the site of the present South Atlantic (for which no subsurface structural evidence has been found, but which seems the most obvious route), or via an east Pacific to south-western Indian Ocean route (there is a western exit to the Neuquen Basin), is not known. *M. nematis* also occurs on the Mozambique Ridge (DSDP site 249) and in Madagascar, giving a geographical range of at least 6 500 km. Faunal continuity across western South Gondwanaland at the time of initial continental drifting between southern Africa and South America is, therefore, an established element in the pre-mid-Cretaceous palaeogeography. This conclusion is at variance with that reached by Jones & Plafker (1977) who studied the Mesozoic molluscs from DSDP sites 327 and 330 on the Falkland Plateau. On the basis of the presence of bivalves such

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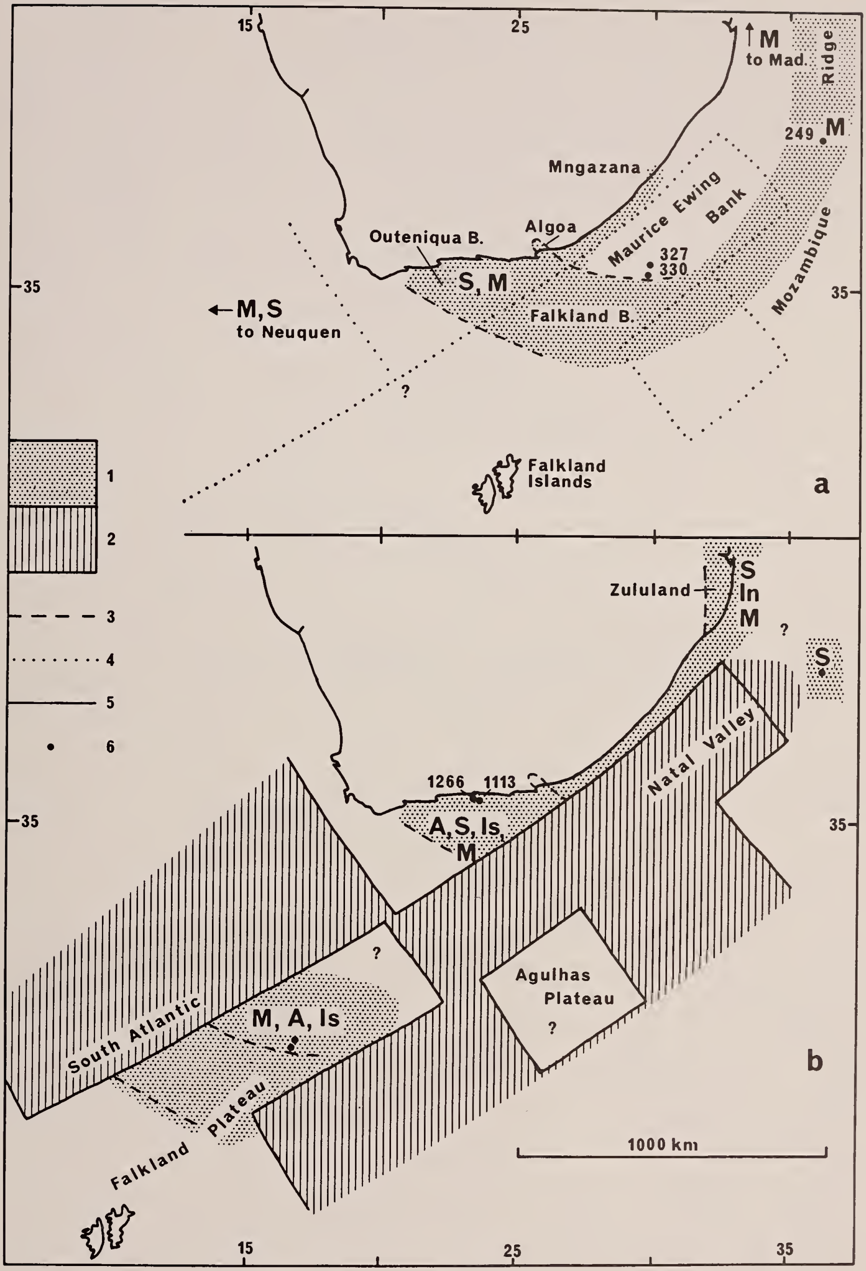
Fig. 42. Mid-Cretaceous palaeogeographies and ostracod distribution in south-east Africa and the Falkland Plateau. Refits are based on Dingle & Scrutton (1974), Tucholke *et al.* (1981), Scrutton (1976), Martin *el al.* (1981), Dingle *et al.* (1983). a. Pre-drift palaeogeography (Valanginian). Ostracod distributions relate to pre- (Valanginian) and earliest- (Hauterivian) drift times. The extension of shallow marine conditions north-west of the Maurice Ewing Bank are suggested by the occurrence of ?Valanginian ostracods at Mngazana on the Transkei coast (McLachlan *et al.* 1976*a*). b. Early Cenomanian palaeogeography (say 99 m.y.). Ostracod distributions relate to mid-Albian to early Cenomanian times (except *Sondagella theloides* on the Mozambique Ridge, recorded in early Aptian or Barremian).

Key: 1—shallow marine conditions on continental crust; 2—deep water conditions on oceanic crust; 3—boundaries of Outeniqua–Falkland Basin (probably faulted); 4—lines of subsequent continental separation; 5—continental edges; 6—sampling sites, 249 DSDP leg 25, 327 and 330 DSDP leg 36, 1113 and 1266 dredge sites on Agulhas Bank.

Abbreviations: M—*Majungaella* spp. (all *M. nematis* except *M?* sp. 327/16 on Falkland Plateau and *M.* cf. *queenslandensis* in the Outeniqua Basin in (b)); S—*Sondagella theloides*; A—*Arculicythere tumida*; Is—*Isocythereis sealenis*; In—*Isocythereis? ndumuensis*. Mad—Madagascar, B—Basin. Faunal data from numerous references cited in the text.


15
25
35
M
to Mad.
Ridge
249
Mngazana
Maurice Ewing
Bank
Mozambique
Outeniqua B.
Algoa
327
330
S, M
M, S
to Neuquen
Falkland B.
?
1
2
3
4
5
6
Falkland
Islands
a
Zululand
S
In
M
?
S
Natal Valley
1266
1113
A, S, Is,
M
?
Agulhas
Plateau
?
M, A, Is
South Atlantic
Falkland
Plateau
b
1000 km

as *Aucellina* and *Malayomaorica*, these workers faunally linked the Jurassic and Lower Cretaceous Falkland Plateau with austral sites in the East Indies, Australasia and Pacific South America, and drew a distinction between them and the Tethyan faunas of south-east Africa and Madagascar. To account for this apparent anomaly they suggested that either the Falkland Plateau did not originally lie off south-east Africa, or that the two areas were separated by a land or oceanographic barrier. We believe that studies such as those by Norton & Sclater (1979) and Martin *et al.* (1981) have firmly established the relative palaeoposition of the Falkland Plateau, and that the remaining disparity may be caused by our lack of knowledge of south-east African Jurassic and Lower Cretaceous bivalves, which await modern taxonomic revision. Certainly, our study of the benthic ostracods do not lend support to Jones & Plafker's main conclusions.

The post-drift palaeogeography shown in Figure 42b is designed to illustrate the situation immediately following continental separation between the Falkland Plateau and the Agulhas Bank (latest Albian), whilst faunal details shown at the various sites cover the period mid-Albian (Albian III) to early Cenomanian. By the beginning of this period, anoxic conditions over the Falkland Plateau DSDP sites and in the deep parts of the narrow South Atlantic basin had largely been dispelled, and marine ostracod faunas had become established, at least in the former area. During the period covered by Figure 42b, final continental separation between southern Africa and the Falkland Plateau (i.e. South America) took place, and after about 100 m.y. (latest Albian) no shallow-water (continental shelf depth) connections persisted between the two areas. As sea-floor spreading proceeded, the gap between the two areas progressively increased, presumably preventing any further contact between elements in ostracod populations that were adapted solely to shallow-water environments.

MID-CRETACEOUS FAUNAL LINKS BETWEEN SOUTH-EAST AFRICA AND THE FALKLAND PLATEAU

Mid-Cretaceous faunal relationships are summarized in Table 13 and Figure 42b. Localities from which data are available are different to those shown in the pre-drift palaeogeography: no marine sediments of Barremian to Lower Maastrichtian age are known from the Neuquen Basin, while in mid-Cretaceous times, marine sedimentation commenced in Zululand and recommenced on the Maurice Ewing Bank. *Sondagella theloides* occurs in the Outeniqua Basin and in Zululand, but appears not to have spread to the eastern Falkland Plateau when normal marine conditions became re-established in early Albian times, even though it originally extended westward into the Neuquen Basin, and has been recorded from the Mozambique Ridge (DSDP 249). Its known upper limit is Albian III (in Zululand) (Fig. 41). The genus *Majungaella*, on the other hand, did migrate into the Falkland Plateau area, presumably from the Outeniqua Basin which lay adjacent to it in middle Albian times. *Majungaella nematis* is known to extend into the Cenomanian in Zululand, but only rare specimens of related species are known from Albian strata of the Outeniqua Basin *(M.* cf.

TABLE 13
Summary of faunal links.

(a) South-east Africa and the Falkland Plateau	
primary links	
Sondagella theloides	OB–Z–N*
Majungaella nematis	OB*–Z–N*–M*
Arculicythere tumida	OB–FP–Au
Isocythereis sealensis	OB–FP
I? ndumuensis	Z
Robsoniella falklandensis	FP–Au
Pirileberis spp.	Z–M
secondary links	
Aitkenicythere? spp.	FP with U.Jur. Au, T
Procytherura cf. *aerodynamica*	Z with Kimm. T
P. cf. *dinglei*	FP with Haut/Val. OB
P. batei	FP similar to *P. maculata* from Haut. OB
	FP similar to *Paijenborchellina* sp. 1 (Damotte)
Cytherura? oertlii	FP with Alb. Au
(b) Between Zululand, Madagascar, Tanzania	
Pirileberis	Z–T–M
Pongolacythere	Z similar to T

Abbreviations:
OB = Outeniqua Basin (Agulhas Bank + Algoa), Z = Zululand, FP = Falkland Plateau, N = Neuquen, Au = Australia, M = Madagascar, T = Tanzania, U.Jur. = Upper Jurassic, Kimm = Kimmeridgian, Haut = Hauterivian, Val = Valanginian, Alb = Albian.
*pre-Albian occurrences

queenslandensis) and the Falkland Plateau *(Majungaella?* sp. 327/16*)*. The genus was clearly on the wane in this part of Gondwanaland, because in all localities it forms only a minor component of the fauna. In this situation, *Sondagella* and *Majungaella* represent residual elements of the late Jurassic–Lower Cretaceous faunas of South Gondwanaland that had been geographically very extensive (see Dingle 1982).

New elements which did vigorously take advantage of the radical and evolving palaeogeographic dispensation were the genera *Isocythereis* and *Arculicythere*. Presumably because of newly established circulation patterns and the resultant environmental disparities, the faunas of Zululand and the Outeniqua Basin show only weak links in these new taxa, whereas the latter and the Falkland Plateau, which were still physically joined in Albian times (although possibly bathymetrically separated by the shallow or emergent region of the Agulhas Arch–Maurice Ewing Bank), have close links at species level. The genus *Isocythereis* is represented by *I. sealensis* in the Outeniqua Basin and Falkland Plateau, and by *I? ndumuensis* in Zululand. These two species are not closely related, emphasizing the relative isolation of the two areas. Similarly, *Arculicythere tumida* occurs at the southern two localities but is absent from Zululand. This species is also present in the Albian of DSDP site 259 of western Australia